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Outdoor Performance of Plastics X. Final Update of Weathering Data

Walter J. Rossiter, Jr.

Center for Building Technology
Institute for Applied Technology
National Bureau of Standards

March 1973

Final Report

Prepared for
Manufacturing Chemists Association
1825 Connecticut Avenue, N. W.
Washington, D. C. 20009



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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

for the
of the

Abstract

Twenty plastics samples have been weathered in Arizona, Florida, and Washington, D. C. for 72 months. The weathering of these samples has been followed by measuring changes in the specimen's color, tensile, flexure, gloss, and haze properties. Computer-generated graphs of these changes with time are presented.

This is the final updating of the Manufacturing Chemists' Association's (MCA) project which studied the outdoor performance of plastics. Since 1966, twenty plastics samples (Table I) have been exposed outdoors at three different exposure sites (Table II) which represent varying climatic conditions encountered in the United States. The MCA project and preliminary results have been described in a series of National Bureau of Standards Reports. These reports [1-9]*, all entitled Outdoor Performance of Plastics, have the following subtitles:

- I. Introduction and Color-Change [1].
- II. Tensile and Flexural Properties [2].
- III. Statistical Model for Predicting Weatherability [3].
- IV. Significance of Climate [4].
- V. Surface Roughness [5].
- VI. Electrical Properties [6].
- VII. Haze and Gloss [7].
- VIII. First Update of Weathering Data [8].
- IX. Second Update of Weathering Data [9].

Changes in those properties listed in the above subtitles were the means for determining the outdoor performance of the twenty samples. A computer was used for data storage and retrieval. Graphs of property vs. outdoor exposure time were generated by the computer. These graphs were reproduced in the various reports as the method of reporting property changes.

* Numbers in brackets refer to references which are found in the back of this report.

From the preliminary results, it was decided that color, tension, flexure, gloss, and haze would be the significant properties to follow for the remainder of the project. The samples remaining have now been exposed outdoors for 72 months. These five properties have been measured for each plastic. The physical testing was again performed by MCA member companies (Table III), and the test results sent here to the National Bureau of Standards for incorporation with the earlier data. Although these data were originally reported in three separate NBS reports [1, 2, 7], the data through 72 months for the five properties are all presented in this single report.

Experimental details are not given here; such details can be found in the earlier reports. Again, the data are presented as reproductions of the computer-generated graphs (Figures 1-81B). These graphs differ from the earlier ones in that the X-axis (time in months) has been expanded to 72 months. Thus, the data points are compressed when compared to those of the original graphs.

This report includes all previous data. Some plastics have failed in the field and obviously there are no additional data for these samples. Graphs with the expanded time have been reproduced for those samples for which there are no additional data. This report is meant to be a replacement for the two previous supplemental ones [8, 9]. The weathering of the plastics can be followed without reference to them. The graphs are identical except for the additional data.

The color data presented in the first report [1] were erroneous. These data were corrected in the first supplemental report [8]. No

comparisons can be made between the graphs for color change in the first report and any of the updates.

This report is only intended as a presentation of the new data. No discussion of the accumulated data is presented.

References

- [1] "Outdoor Performance of Plastics. I. Introduction and Color-Change", J. E. Clark, N. E. Green, and P. Giesecke, NBS Report #9912, Sept. 1968.
- [2] "Outdoor Performance of Plastics. II. Tensile and Flexural Properties", J. E. Clark, G. E. Gulmer, R. C. Neuman, and J. A. Slater, NBS Report #10014, March 1969.
- [3] "Outdoor Performance of Plastics. III. Statistical Model for Predicting Weatherability", J. E. Clark and J. A. Slater, NBS Report #10016, Oct. 1969.
- [4] "Outdoor Performance of Plastics. IV. Significance of Climate", J. E. Clark and C. Bal Krishna, NBS Report #10156, Jan. 1970.
- [5] "Outdoor Performance of Plastics. V. Surface Roughness", J. E. Clark, C. Bal Krishna, H. C. Gunst, and J. R. Dagon, NBS Report #10179, March 1970.
- [6] "Outdoor Performance of Plastics. VI. Electrical Properties", J. E. Clark, J. A. Slater, and V. L. Bergeron, NBS Report #10185, March 1970.
- [7] "Outdoor Performance of Plastics. VII. Haze and Gloss", J. E. Clark, C. Bal Krishna, G. C. Claver, and F. H. McTigue, NBS Report #10188, March 1970.
- [8] "Outdoor Performance of Plastics. VIII. First Update of Weathering Data", W. J. Rossiter, Jr. and W. D. Hayes, Jr., NBS Report #10479, September 1971.
- [9] "Outdoor Performance of Plastics. IX. Second Update of Weathering Data", W. J. Rossiter, Jr., NBS Report #10856, May 1972.

Table I

List of Twenty Plastics

<u>Base Polymer</u>	<u>Plastic</u>
Polyethylene	Translucent - 1 mil - 60 mil
Poly (methyl methacrylate)	Clear - 60 mil
Poly (vinyl fluoride)	Clear - 1 mil
Poly (ethylene terephthalate)	Clear - 5 mil
Polyester/x-linked	Clear - 60 mil
Poly (vinyl chloride)	Clear - 4 mil - 10 mil - 60 mil <u>Ba-Cd</u> Clear - 4 mil - 10 mil - 60 mil <u>Sn</u> Clear - 60 mil White - 4 mil - 10 mil - 60 mil <u>Ba-Cd</u> White - 4 mil - 10 mil - 60 mil <u>Sn</u> White - 60 mil

Table II

Exposure Sites

<u>Name and Location</u> *	<u>Letter Designation for Graphs</u>
Desert Sunshine Exposure Tests, Inc. Phoenix, Arizona	A
South Florida Test Service, Inc. Miami, Florida	F
Old NBS Site Connecticut & Van Ness Streets Washington, D. C.	W

* Samples were placed on the exposure racks facing south at 45° from the horizontal.

Table III

Plastics Evaluation

Property	Company & Location
Color	American Cyanamid Company Stamford, Connecticut
Tensile Flexure	W. R. Grace & Company Clarksville, Maryland
Haze	Monsanto Company Indian Orchard, Massachusetts
Gloss	Hercules Incorporated Wilmington, Delaware

List of Figures

Numbers

1 - 20	Color-change, ΔE (Delta E)
21 - 40	Ultimate Elongation (% of Initial Value)
41 - 48	5 Percent Stress (PSI)
49 - 68	Gloss (in percent)
69A - 81A	Haze at 421 nm (in percent)
69B - 81B	Haze at 550 nm (in percent)

FIGURE 1

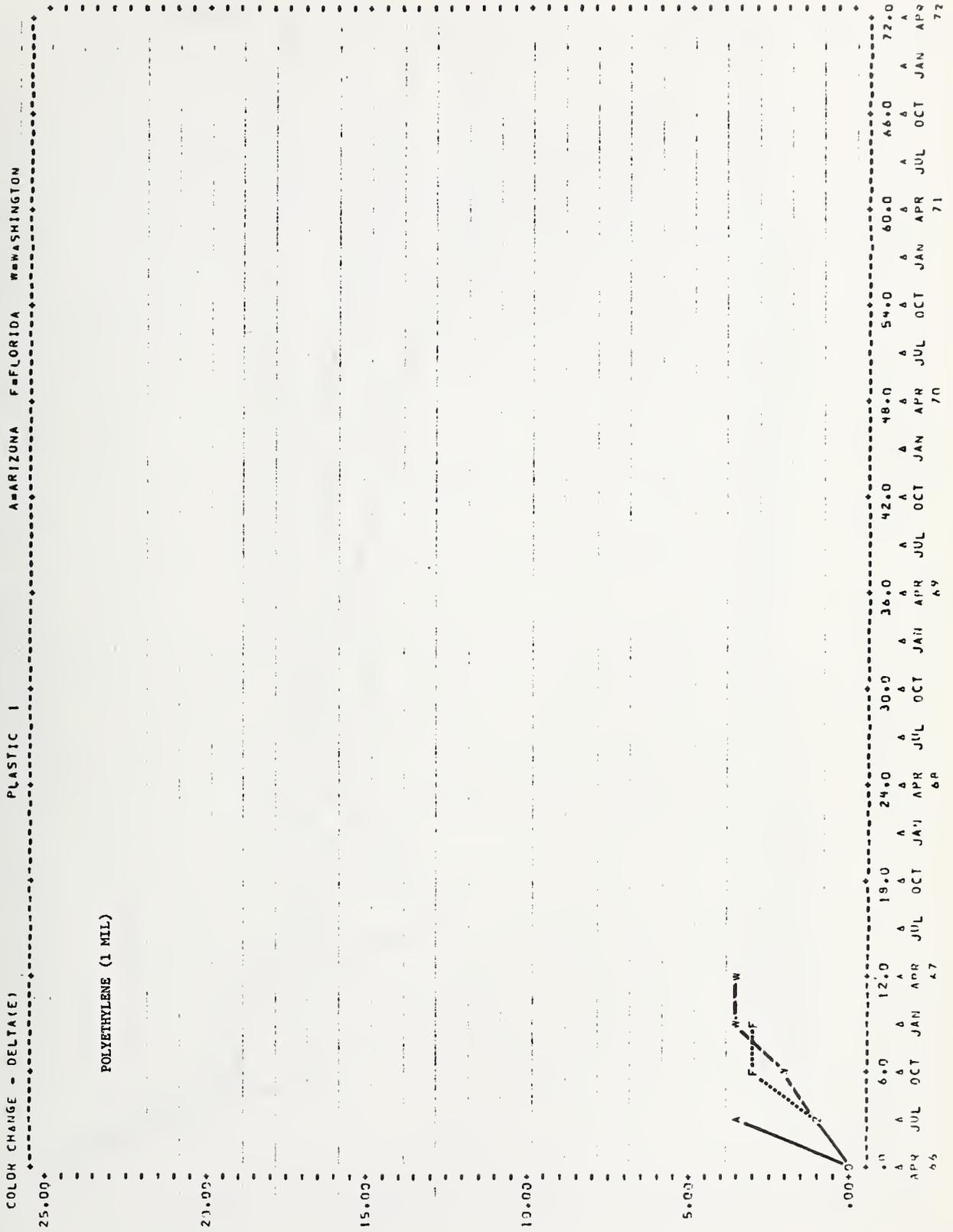


FIGURE 2

COLOR CHANGE - DELTA(E) PLASTIC 2 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE (60 MIL)

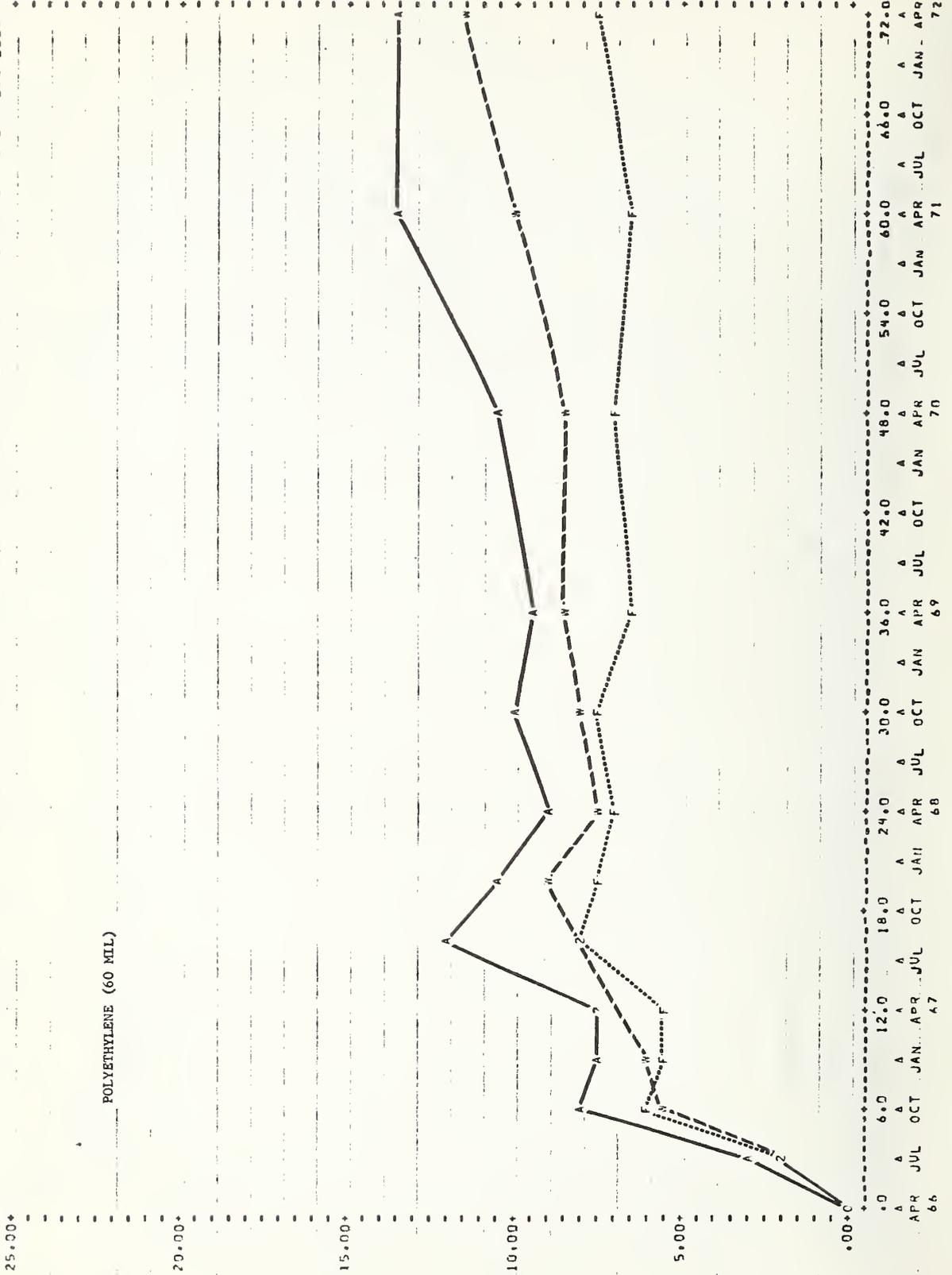


FIGURE 3

COLOR CHANGE - DELTAE) PLASTIC 3 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYMETHYL METHACRYLATE (60 MIL)

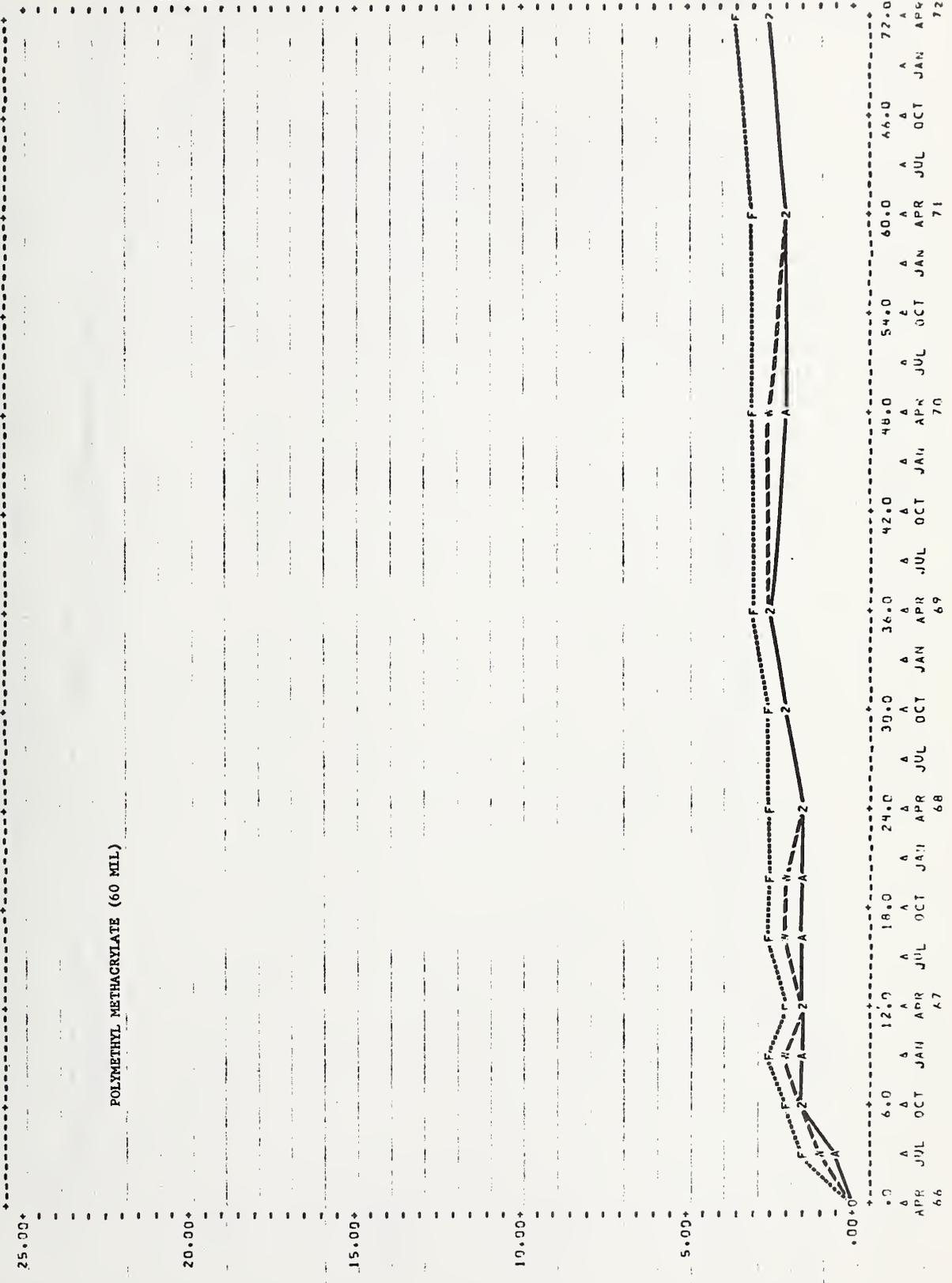
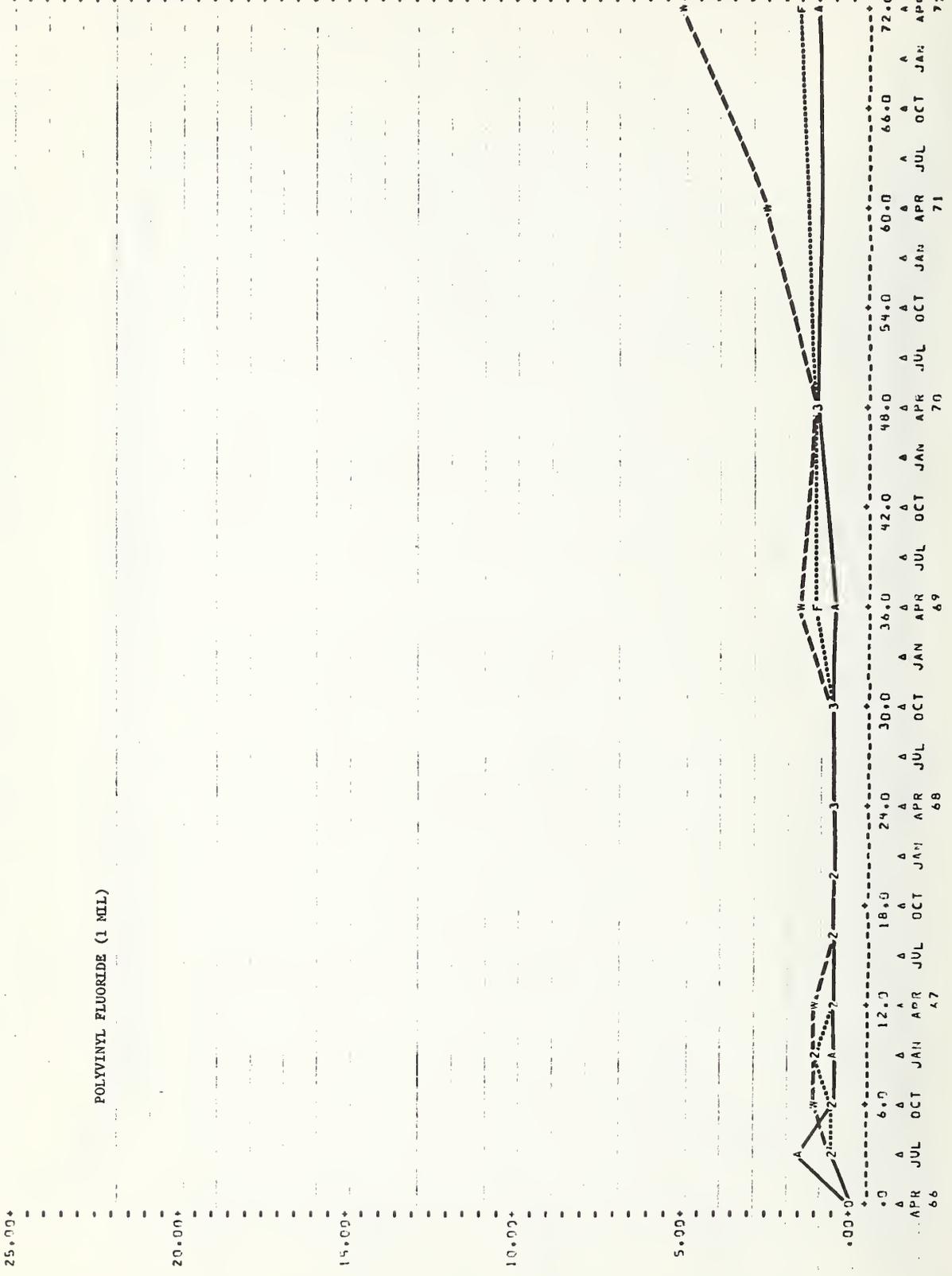


FIGURE 4

COLOR CHANGE - DELTA(E) PLASTIC 4 ARIZONA F=FLORIDA W=WASHINGTON



POLYVINYL FLUORIDE (1 MIL)

25.00

20.00

15.00

10.00

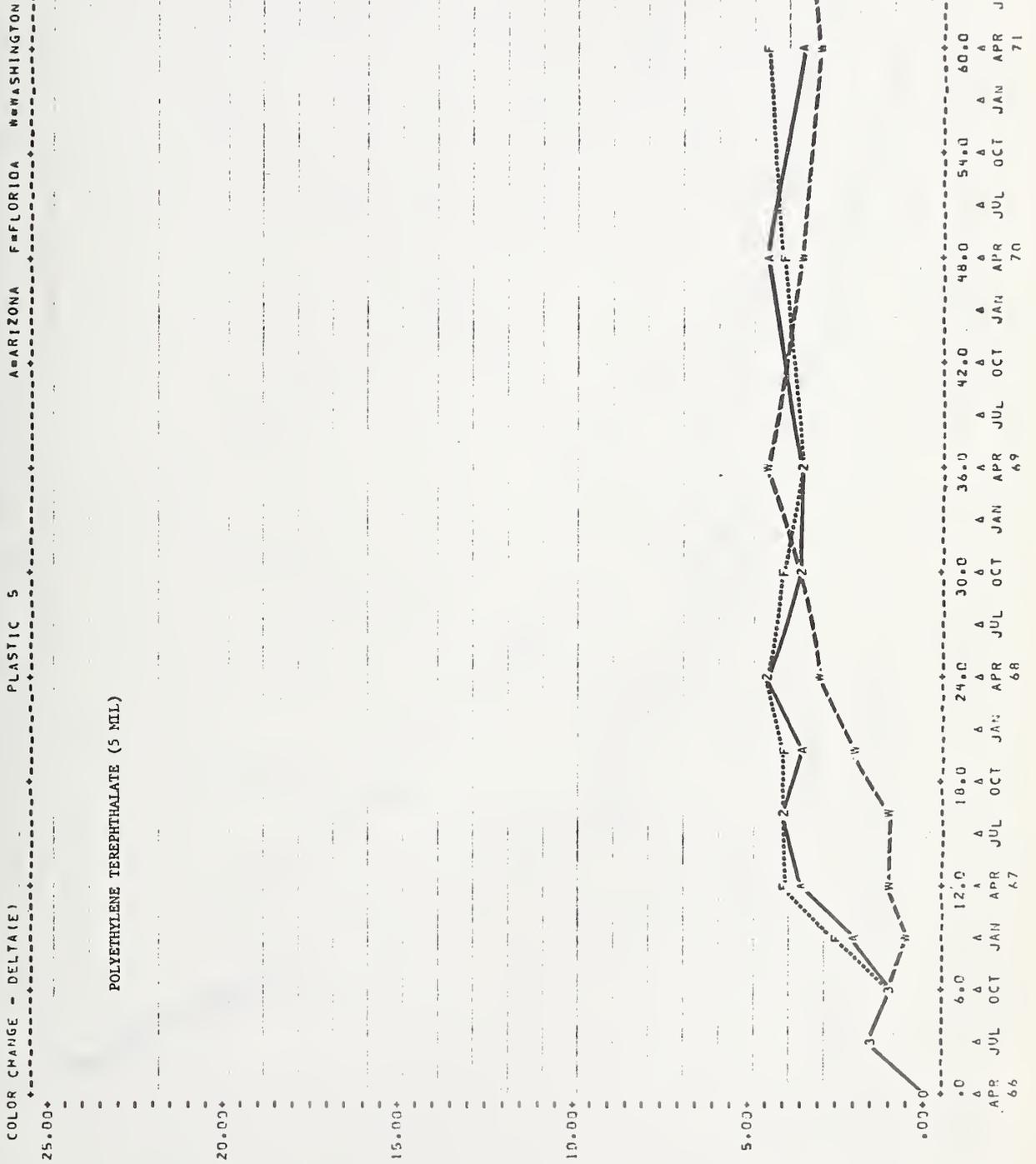
5.00

0.00

APR JUL OCT

66 67 68 69 70 71 72

FIGURE 5



COLOR CHANGE - DELTA(E) PLASTIC 6 A=ARIZONA F=FLORIDA W=WASHINGTON

GLASS-REINFORCED POLYESTER (60 MIL)

FIGURE 6

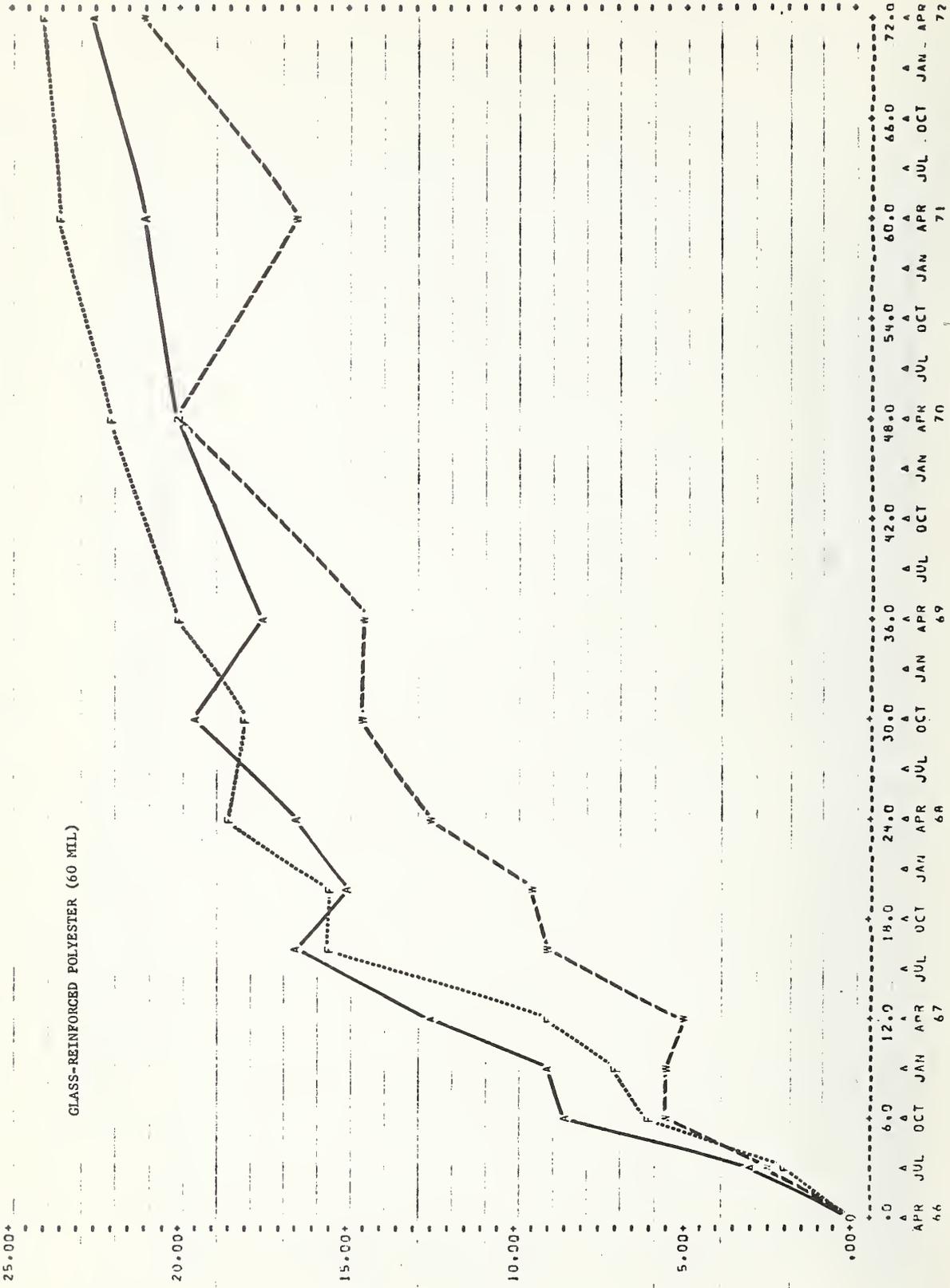
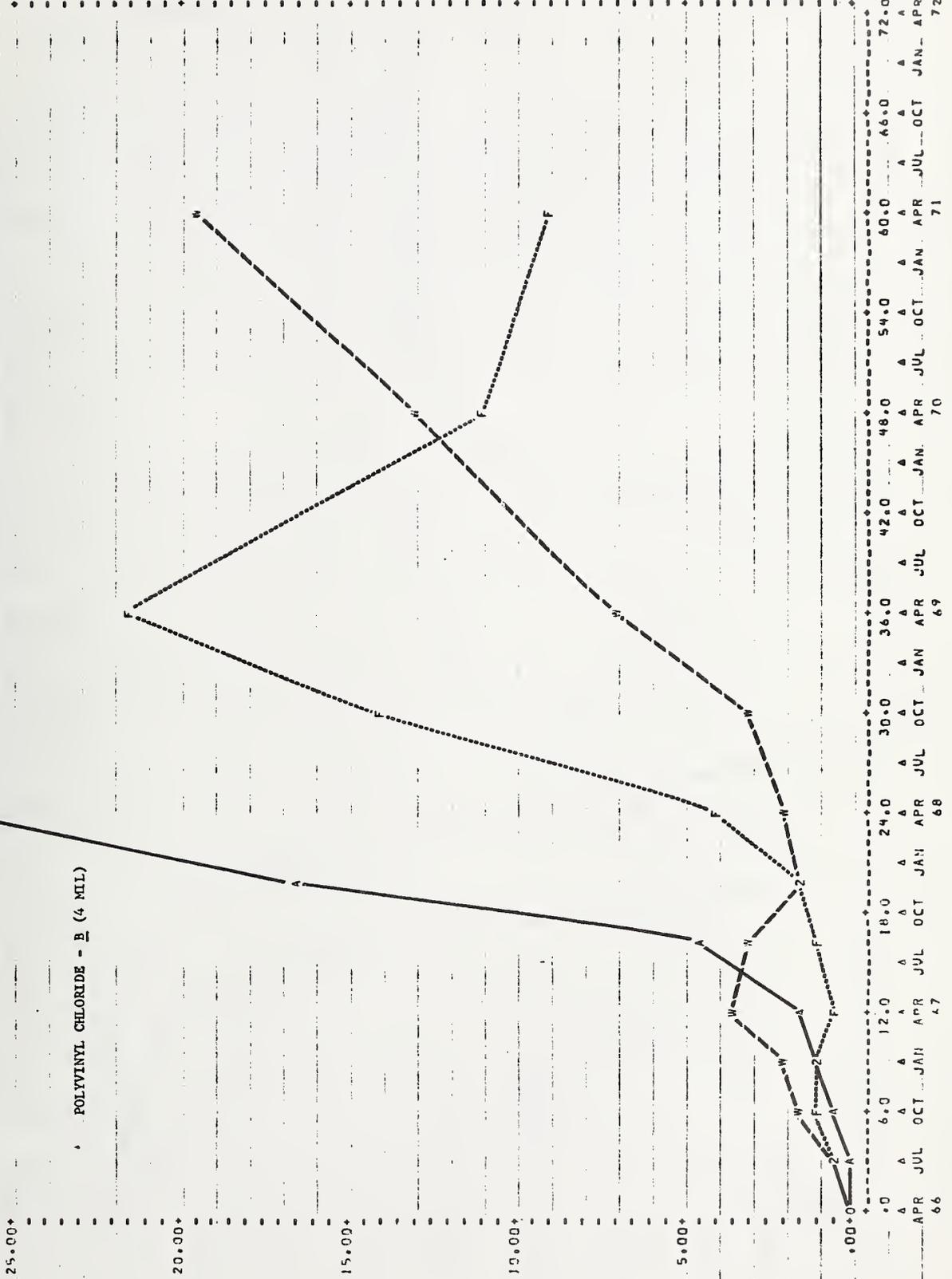


FIGURE 7

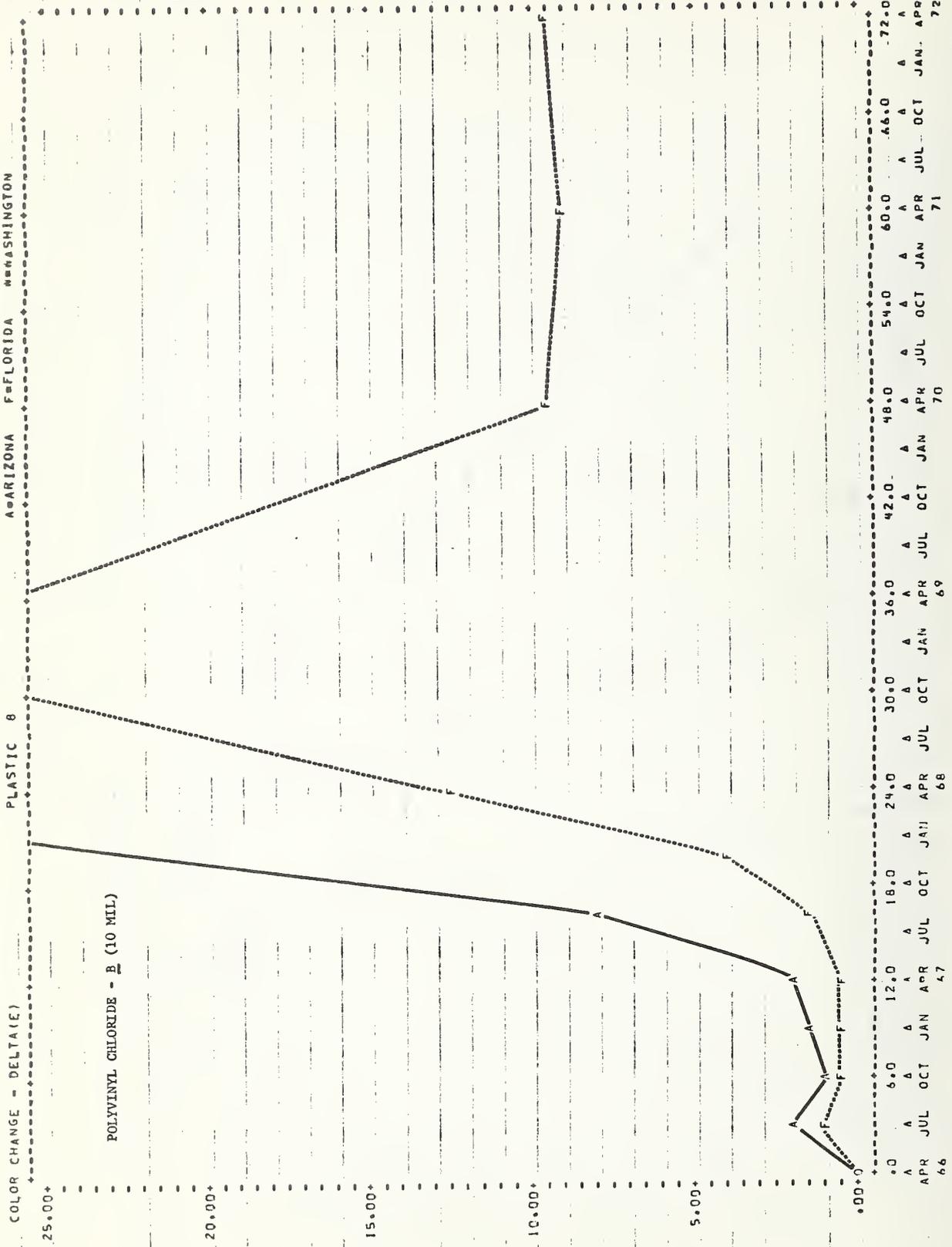
COLOR CHANGE - DELTA(E) PLASTIC 7 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)



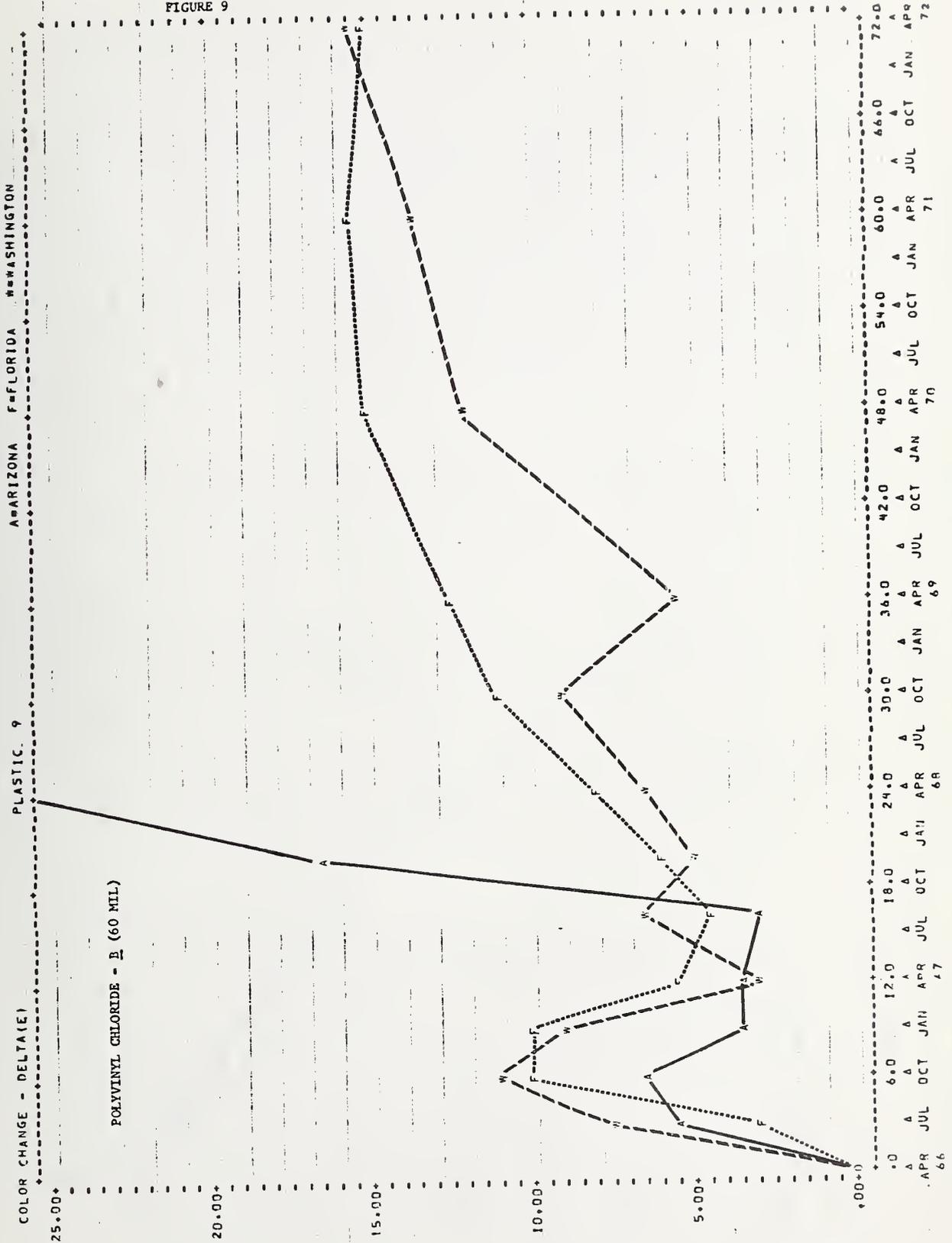
NOTE. 2 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 8



NOTE. 6 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 9



NOTE. 5 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 10

COLOR CHANGE - DELTA(E) PLASTIC 10 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - C (4 MIL)

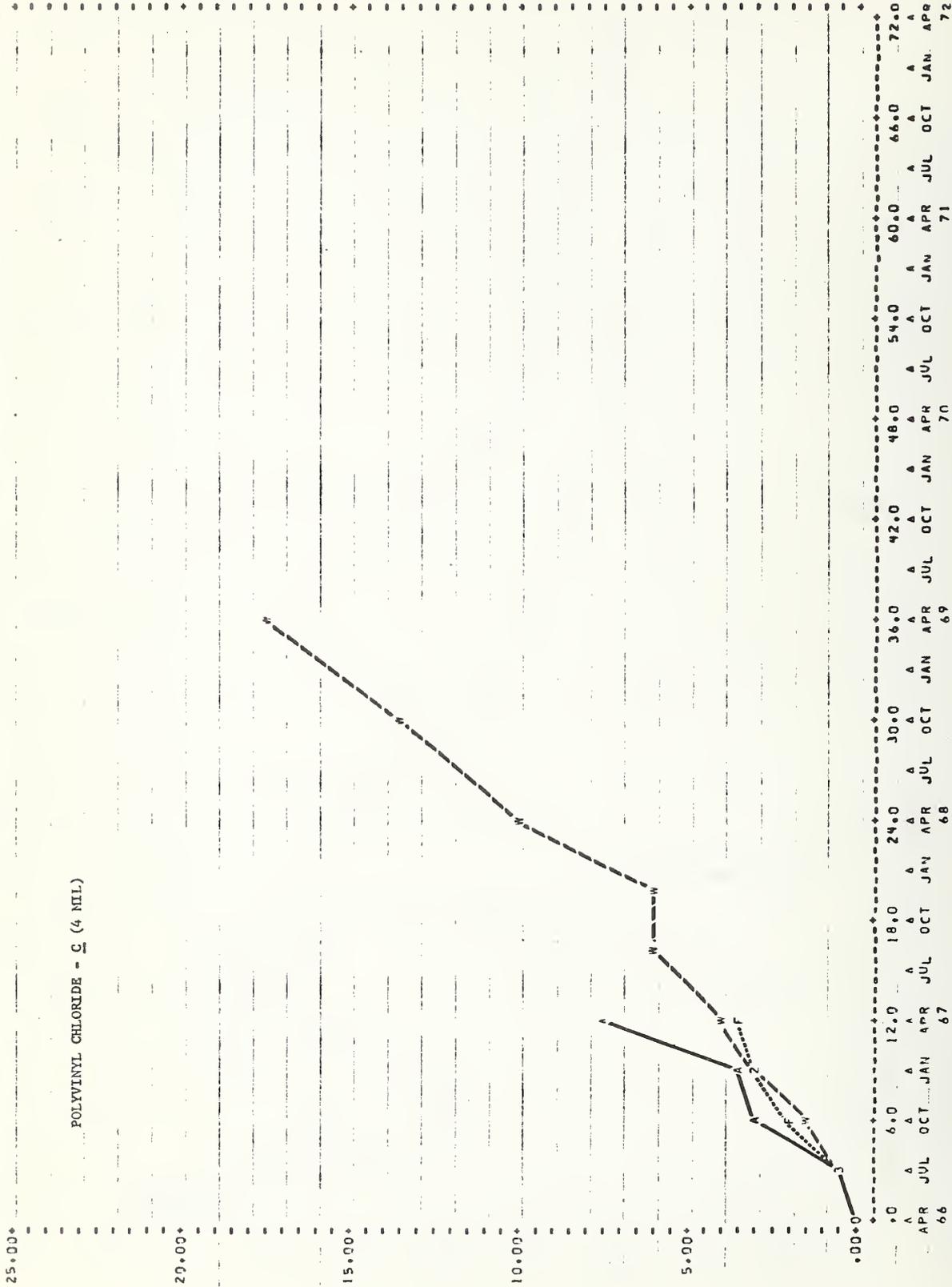
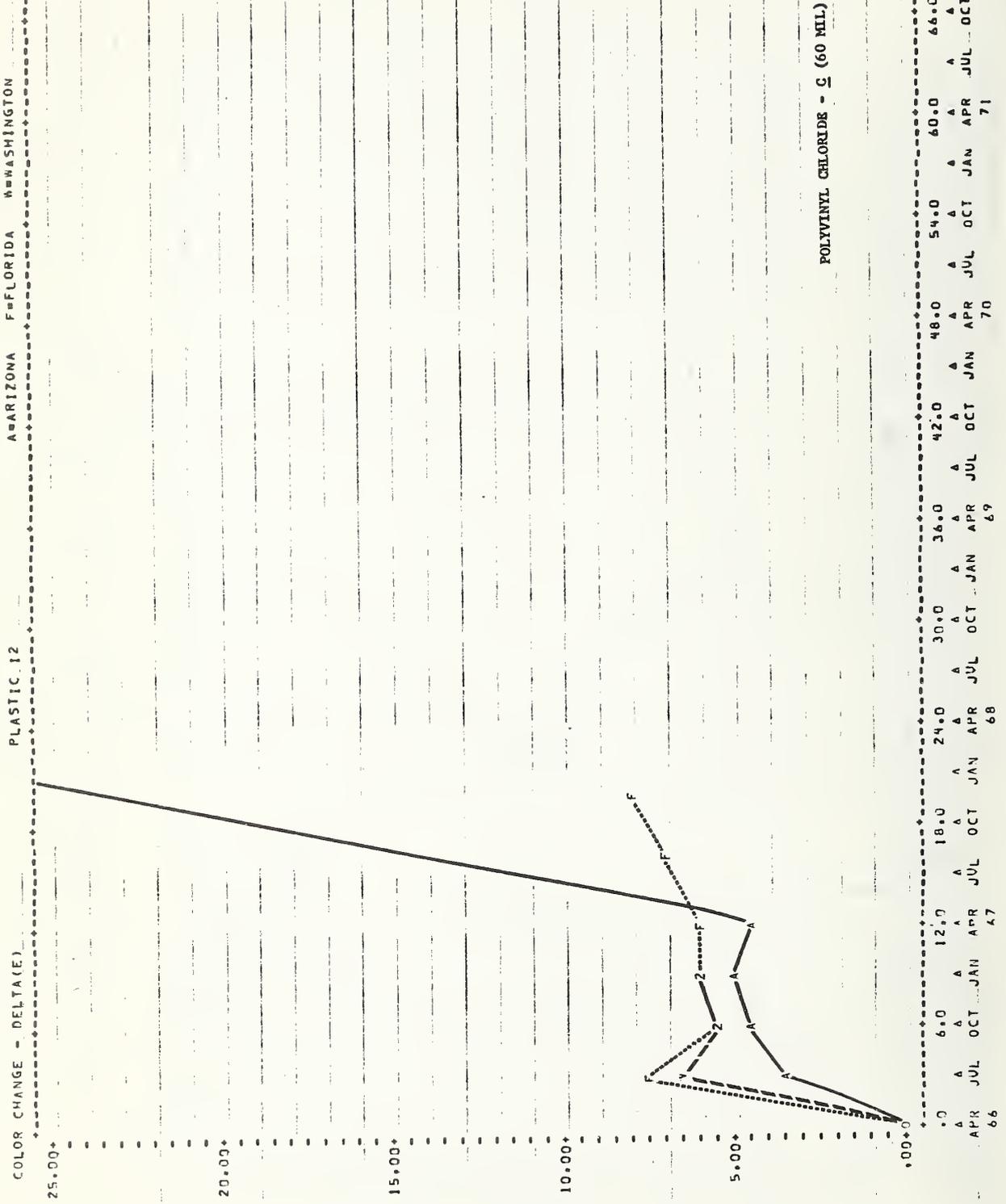
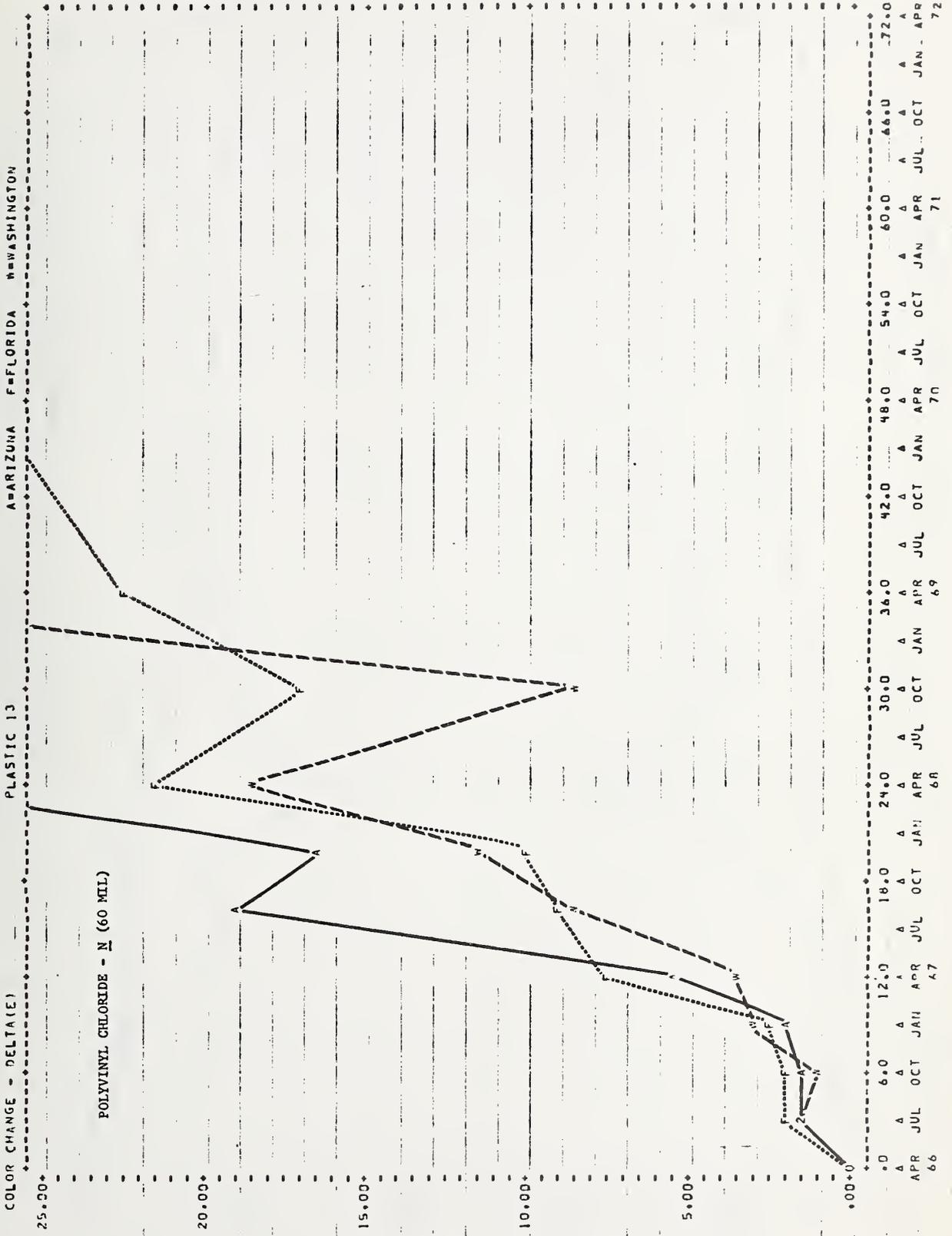


FIGURE 12



NOTE: 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 13



NOTE: 11 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 16

PLASTIC 16

A=ARIZONA F=FLORIDA W=WASHINGTON

COLOR CHANGE - DELTA(E)

25.00+

POLYVINYL CHLORIDE - A (60 MIL)

20.00+

15.00+

10.00+

5.00+

0.00+

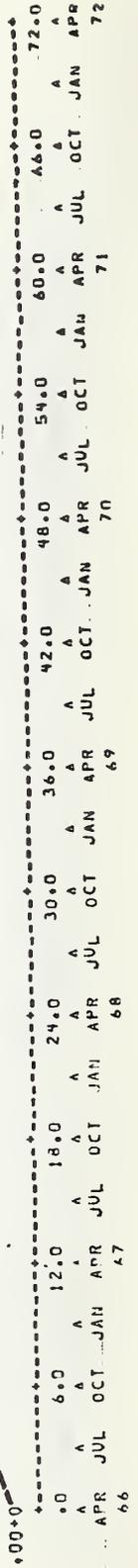


FIGURE 17

COLOR CHANGE - DELTA(E) PLASTIC 17 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - D (4 MIL)

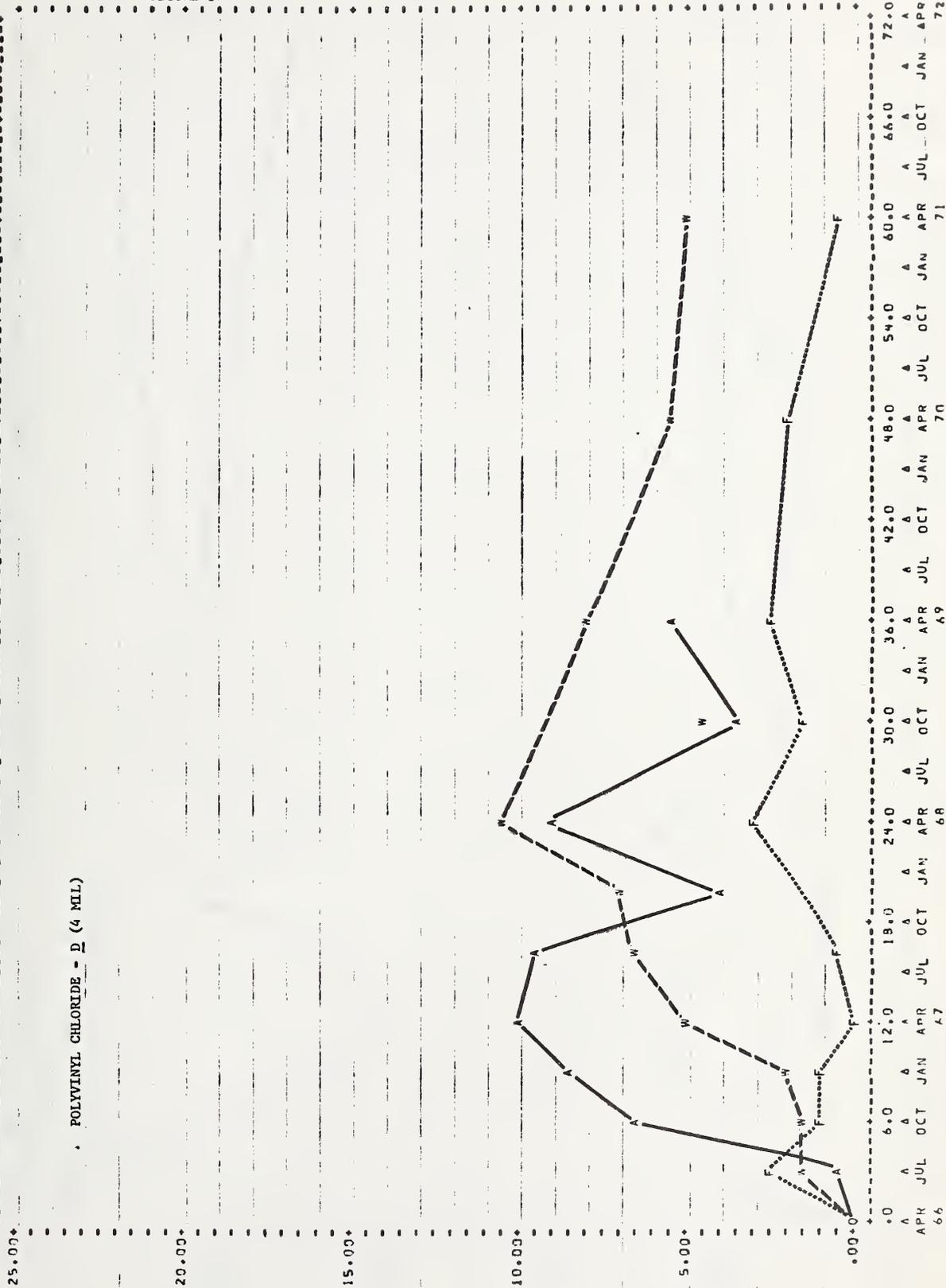


FIGURE 18

COLOR CHANGE - DELTA(E) PLASTIC 1B ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - D (10 ML)

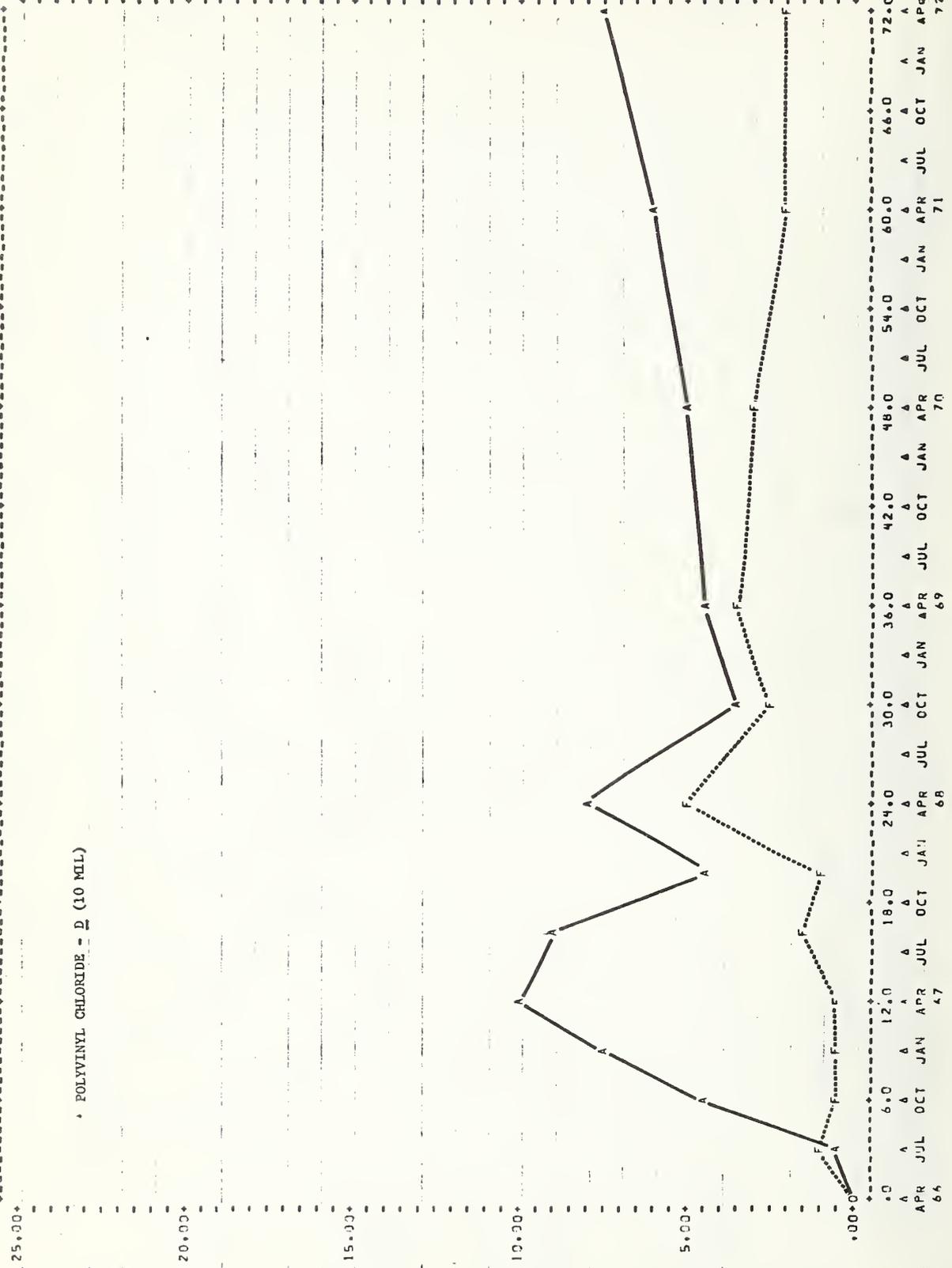


FIGURE 19

COLOR CHANGE - DELTA(E) PLASTIC 19 A=ARIZONA F=FLORIDA W=WASHINGTON

25.00+

POLYVINYL CHLORIDE - D (60 MIL)

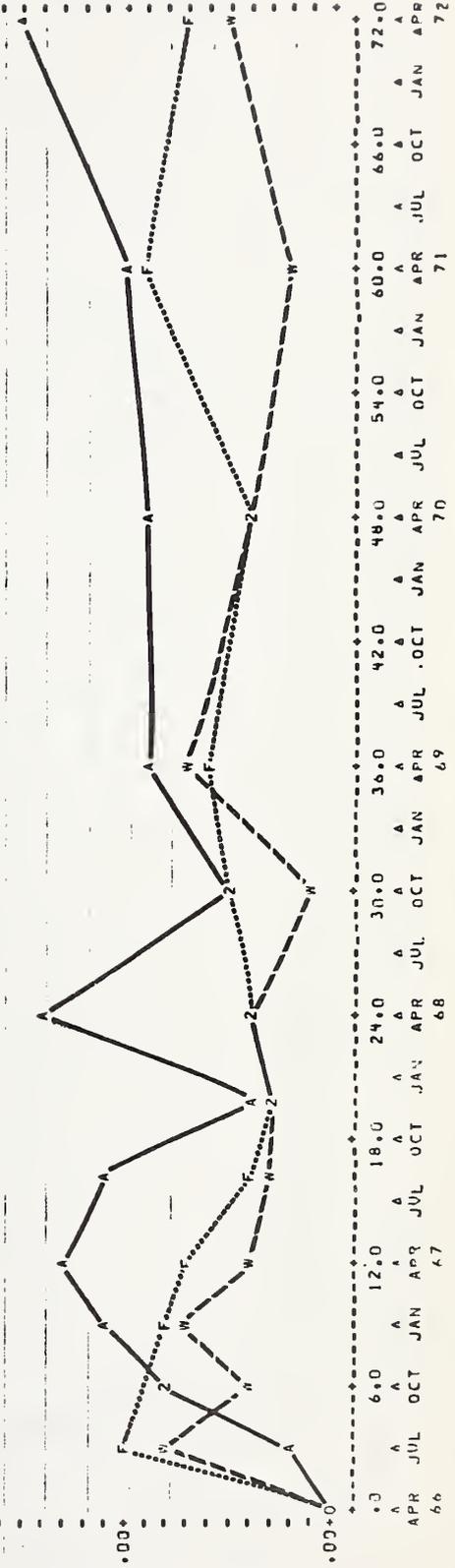
20.00+

15.00+

10.00+

5.00+

0.00+

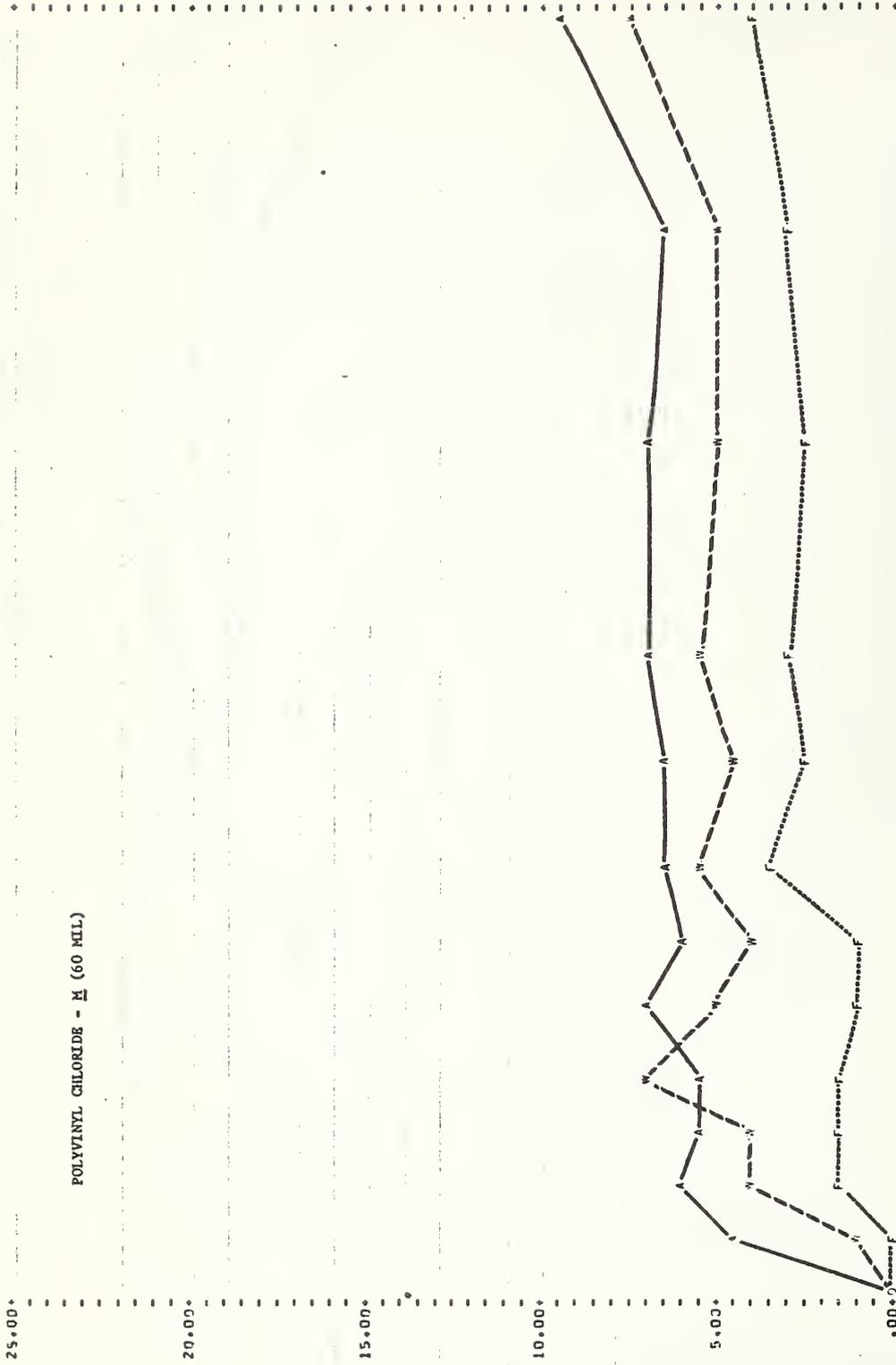


66 67 68 69 70 71 72

FIGURE 20

COLOR CHANGE - DELTA(E) PLASTIC 20

POLYVINYL CHLORIDE - M (60 MIL)



25.00
20.00
15.00
10.00
5.00
0.00

0.0 6.0 12.0 18.0 24.0 30.0 36.0 42.0 48.0 54.0 60.0 66.0 72.0

APR JUL OCT JAN APR

66 67 68 69 70 71 72

FIGURE 21

ULTIMATE FLOWGATION (PERCENT OF INITIAL VALUE) PLASTIC 1 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE (1 MIL)

INITIAL VALUE = 504.0%

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

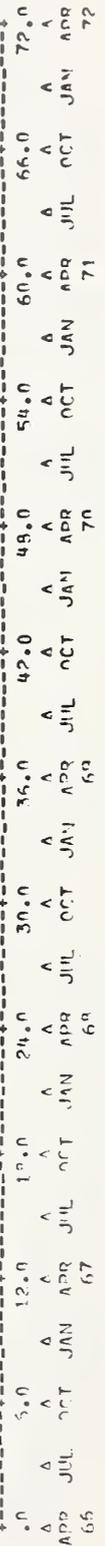
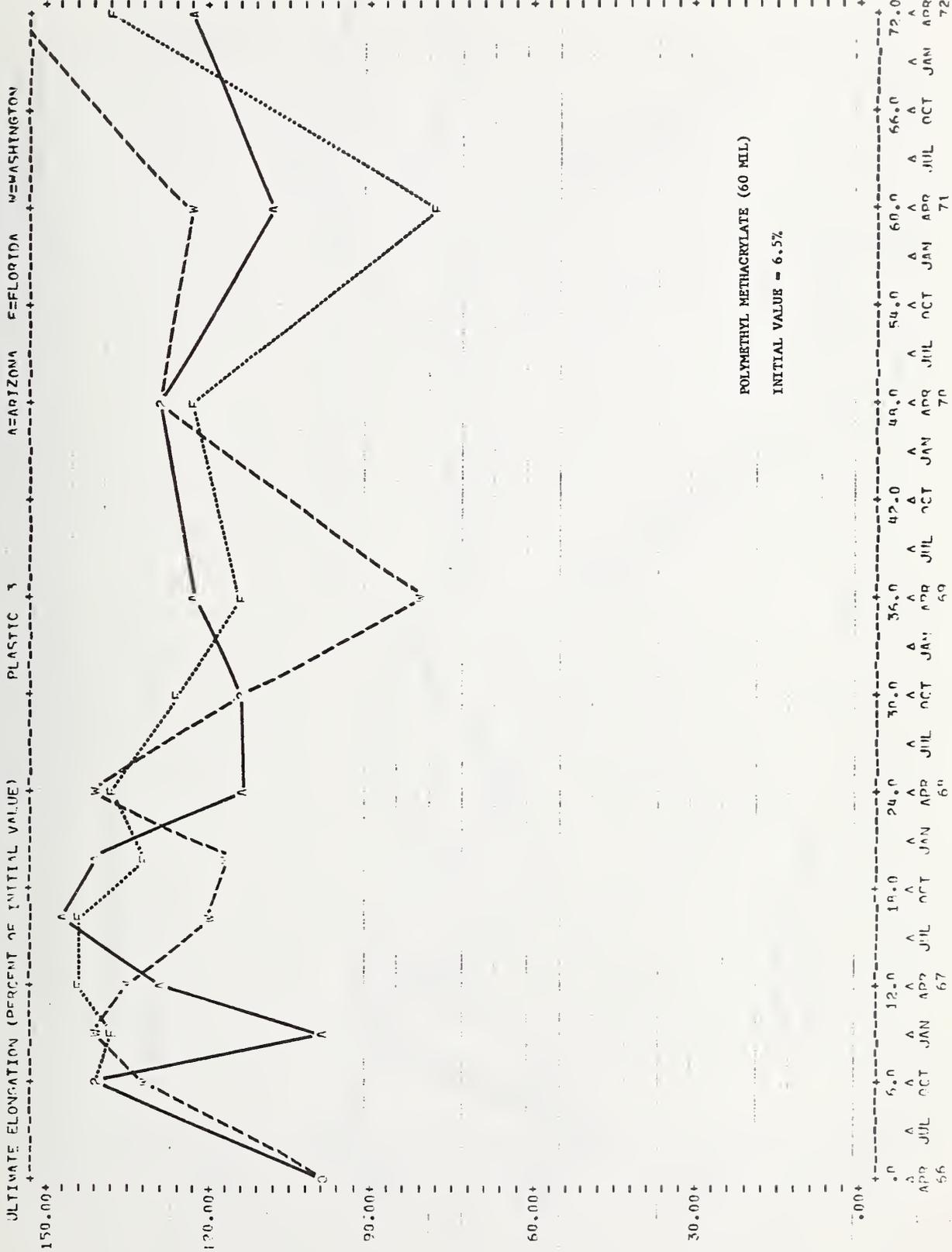


FIGURE 23



POLYMETHYL METHACRYLATE (60 MIL)
INITIAL VALUE = 6.5%

**NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 24

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 4

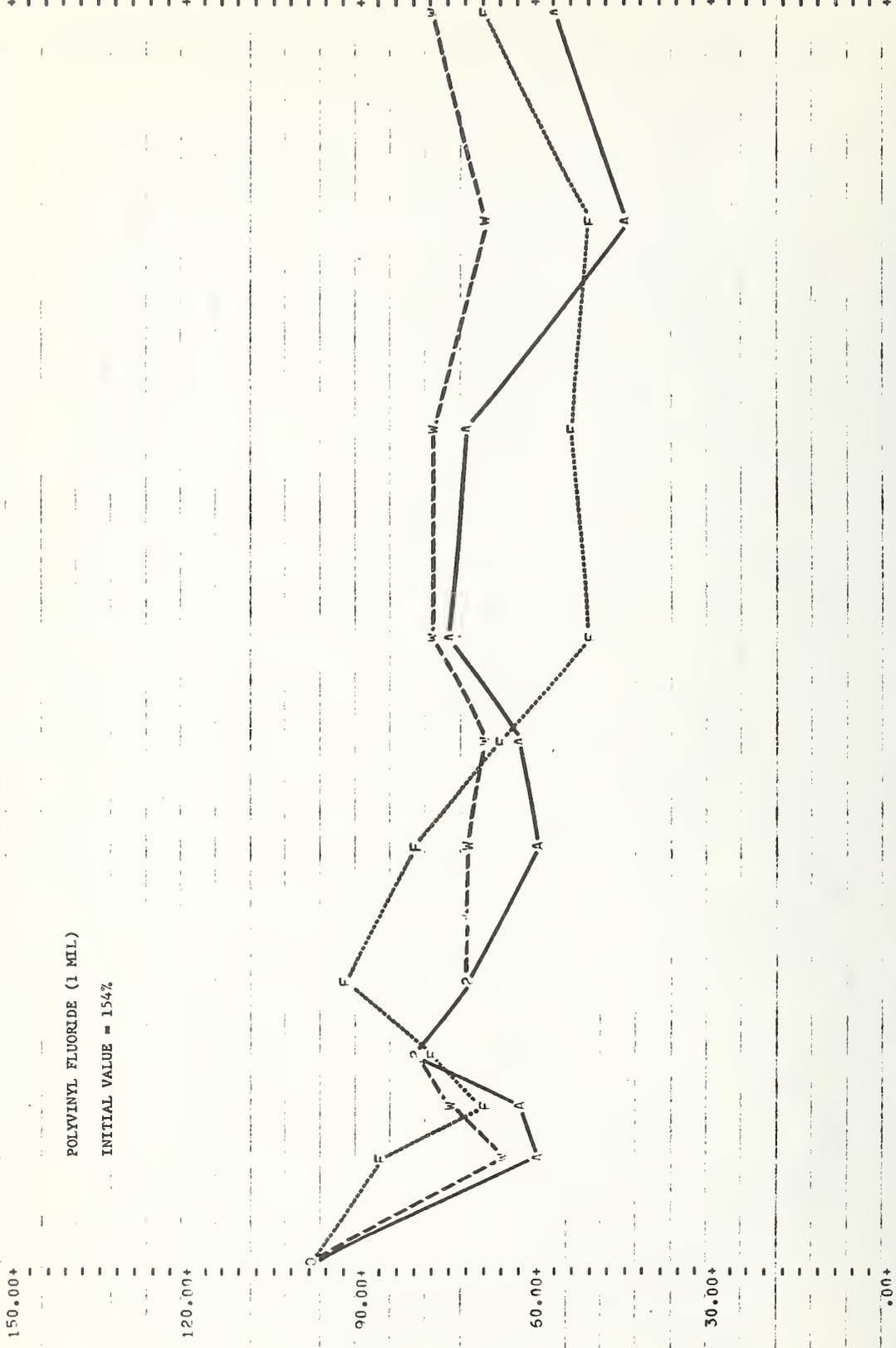
WASHINGTON

FLORIDA

ARIZONA

POLYVINYL FLUORIDE (1 MIL)

INITIAL VALUE = 154%



Year	Washington (%)	Florida (%)	Arizona (%)
56	50	40	45
57	55	45	50
58	60	50	55
59	65	55	60
60	70	60	65
61	75	65	70
62	80	70	75
63	85	75	80
64	90	80	85
65	95	85	90
66	100	90	95
67	105	95	100
68	110	100	105
69	115	105	110
70	120	110	115
71	125	115	120
72	130	120	125

FIGURE 26

WASHINGTON

FLORIDA

ARIZONA

PLASTIC 6

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE)

150.00+

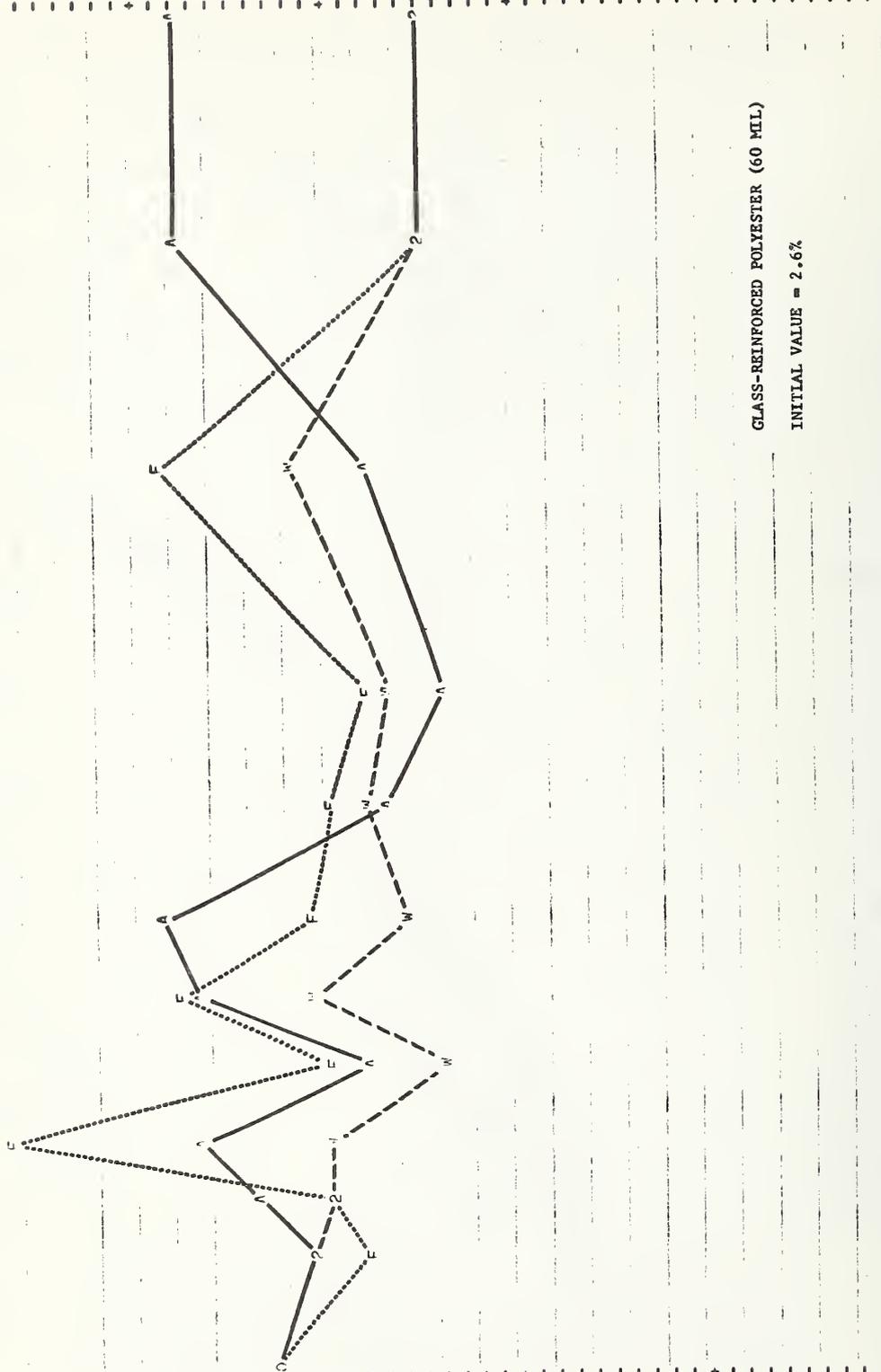
120.00+

90.00+

60.00+

30.00+

.00+



GLASS-REINFORCED POLYESTER (60 MIL)

INITIAL VALUE = 2.6%

Year	Month	Value (Solid Line)	Value (Dashed Line)
1965	APR	10	5
1965	JUL	12	8
1965	OCT	15	10
1966	JAN	18	12
1966	APR	24	18
1966	JUL	30	24
1966	OCT	36	30
1967	JAN	42	36
1967	APR	48	42
1967	JUL	54	48
1967	OCT	60	54
1968	JAN	66	60
1968	APR	72	66
1968	JUL	78	72
1968	OCT	84	78
1969	JAN	90	84
1969	APR	96	90
1969	JUL	102	96
1969	OCT	108	102
1970	JAN	114	108
1970	APR	120	114
1970	JUL	126	120
1970	OCT	132	126
1971	JAN	138	132
1971	APR	144	138
1971	JUL	150	144
1971	OCT	156	150
1972	JAN	162	156
1972	APR	168	162
1972	JUL	174	168
1972	OCT	180	174
1972	JAN	186	180
1972	APR	192	186
1972	JUL	198	192
1972	OCT	204	198
1972	JAN	210	204
1972	APR	216	210
1972	JUL	222	216
1972	OCT	228	222
1972	JAN	234	228
1972	APR	240	234
1972	JUL	246	240
1972	OCT	252	246
1972	JAN	258	252
1972	APR	264	258
1972	JUL	270	264
1972	OCT	276	270
1972	JAN	282	276
1972	APR	288	282
1972	JUL	294	288
1972	OCT	300	294
1972	JAN	306	300
1972	APR	312	306
1972	JUL	318	312
1972	OCT	324	318
1972	JAN	330	324
1972	APR	336	330
1972	JUL	342	336
1972	OCT	348	342
1972	JAN	354	348
1972	APR	360	354
1972	JUL	366	360
1972	OCT	372	366
1972	JAN	378	372
1972	APR	384	378
1972	JUL	390	384
1972	OCT	396	390
1972	JAN	402	396
1972	APR	408	402
1972	JUL	414	408
1972	OCT	420	414
1972	JAN	426	420
1972	APR	432	426
1972	JUL	438	432
1972	OCT	444	438
1972	JAN	450	444
1972	APR	456	450
1972	JUL	462	456
1972	OCT	468	462
1972	JAN	474	468
1972	APR	480	474
1972	JUL	486	480
1972	OCT	492	486
1972	JAN	498	492
1972	APR	504	498
1972	JUL	510	504
1972	OCT	516	510
1972	JAN	522	516
1972	APR	528	522
1972	JUL	534	528
1972	OCT	540	534
1972	JAN	546	540
1972	APR	552	546
1972	JUL	558	552
1972	OCT	564	558
1972	JAN	570	564
1972	APR	576	570
1972	JUL	582	576
1972	OCT	588	582
1972	JAN	594	588
1972	APR	600	594
1972	JUL	606	600
1972	OCT	612	606
1972	JAN	618	612
1972	APR	624	618
1972	JUL	630	624
1972	OCT	636	630
1972	JAN	642	636
1972	APR	648	642
1972	JUL	654	648
1972	OCT	660	654
1972	JAN	666	660
1972	APR	672	666
1972	JUL	678	672
1972	OCT	684	678
1972	JAN	690	684
1972	APR	696	690
1972	JUL	702	696
1972	OCT	708	702
1972	JAN	714	708
1972	APR	720	714
1972	JUL	726	720
1972	OCT	732	726
1972	JAN	738	732
1972	APR	744	738
1972	JUL	750	744
1972	OCT	756	750
1972	JAN	762	756
1972	APR	768	762
1972	JUL	774	768
1972	OCT	780	774
1972	JAN	786	780
1972	APR	792	786
1972	JUL	798	792
1972	OCT	804	798
1972	JAN	810	804
1972	APR	816	810
1972	JUL	822	816
1972	OCT	828	822
1972	JAN	834	828
1972	APR	840	834
1972	JUL	846	840
1972	OCT	852	846
1972	JAN	858	852
1972	APR	864	858
1972	JUL	870	864
1972	OCT	876	870
1972	JAN	882	876
1972	APR	888	882
1972	JUL	894	888
1972	OCT	900	894
1972	JAN	906	900
1972	APR	912	906
1972	JUL	918	912
1972	OCT	924	918
1972	JAN	930	924
1972	APR	936	930
1972	JUL	942	936
1972	OCT	948	942
1972	JAN	954	948
1972	APR	960	954
1972	JUL	966	960
1972	OCT	972	966
1972	JAN	978	972
1972	APR	984	978
1972	JUL	990	984
1972	OCT	996	990
1972	JAN	1002	996
1972	APR	1008	1002
1972	JUL	1014	1008
1972	OCT	1020	1014
1972	JAN	1026	1020
1972	APR	1032	1026
1972	JUL	1038	1032
1972	OCT	1044	1038
1972	JAN	1050	1044
1972	APR	1056	1050
1972	JUL	1062	1056
1972	OCT	1068	1062
1972	JAN	1074	1068
1972	APR	1080	1074
1972	JUL	1086	1080
1972	OCT	1092	1086
1972	JAN	1098	1092
1972	APR	1104	1098
1972	JUL	1110	1104
1972	OCT	1116	1110
1972	JAN	1122	1116
1972	APR	1128	1122
1972	JUL	1134	1128
1972	OCT	1140	1134
1972	JAN	1146	1140
1972	APR	1152	1146
1972	JUL	1158	1152
1972	OCT	1164	1158
1972	JAN	1170	1164
1972	APR	1176	1170
1972	JUL	1182	1176
1972	OCT	1188	1182
1972	JAN	1194	1188
1972	APR	1200	1194
1972	JUL	1206	1200
1972	OCT	1212	1206
1972	JAN	1218	1212
1972	APR	1224	1218
1972	JUL	1230	1224
1972	OCT	1236	1230
1972	JAN	1242	1236
1972	APR	1248	1242
1972	JUL	1254	1248
1972	OCT	1260	1254
1972	JAN	1266	1260
1972	APR	1272	1266
1972	JUL	1278	1272
1972	OCT	1284	1278
1972	JAN	1290	1284
1972	APR	1296	1290
1972	JUL	1302	1296
1972	OCT	1308	1302
1972	JAN	1314	1308
1972	APR	1320	1314
1972	JUL	1326	1320
1972	OCT	1332	1326
1972	JAN	1338	1332
1972	APR	1344	1338
1972	JUL	1350	1344
1972	OCT	1356	1350
1972	JAN	1362	1356
1972	APR	1368	1362
1972	JUL	1374	1368
1972	OCT	1380	1374
1972	JAN	1386	1380
1972	APR	1392	1386
1972	JUL	1398	1392
1972	OCT	1404	1398
1972	JAN	1410	1404
1972	APR	1416	1410
1972	JUL	1422	1416
1972	OCT	1428	1422
1972	JAN	1434	1428
1972	APR	1440	1434
1972	JUL	1446	1440
1972	OCT	1452	1446
1972	JAN	1458	1452
1972	APR	1464	1458
1972	JUL	1470	1464
1972	OCT	1476	1470
1972	JAN	1482	1476
1972	APR	1488	1482
1972	JUL	1494	1488
1972	OCT	1500	1494
1972	JAN	1506	1500
1972	APR	1512	1506
1972	JUL	1518	1512
1972	OCT	1524	1518
1972	JAN	1530	1524
1972	APR	1536	1530
1972	JUL	1542	1536
1972	OCT	1548	1542
1972	JAN	1554	1548
1972	APR	1560	1554
1972	JUL	1566	1560
1972	OCT	1572	1566
1972	JAN	1578	1572
1972	APR	1584	1578
1972	JUL	1590	1584
1972	OCT	1596	1590
1972	JAN	1602	1596
1972	APR	1608	1602
1972	JUL	1614	1608
1972	OCT	1620	1614
1972	JAN	1626	1620
1972	APR	1632	1626
1972	JUL	1638	1632
1972	OCT	1644	1638
1972	JAN	1650	1644
1972	APR	1656	1650
1972	JUL	1662	1656
1972	OCT	1668	1662
1972	JAN	1674	1668
1972	APR	1680	1674
1972	JUL	1686	1680
1972	OCT	1692	1686
1972	JAN	1698	1692
1972	APR	1704	1698
1972	JUL	1710	1704
1972	OCT	1716	1710
1972	JAN	1722	1716
1972	APR	1728	1722
1972	JUL	1734	1728
1972	OCT	1740	1734
1972	JAN	1746	1740
1972	APR	1752	1746
1972	JUL	1758	1752
1972	OCT	1764	1758
1972	JAN	1770	1764
1972	APR	1776	1770
1972	JUL	1782	1776
1972	OCT	1788	1782
1972	JAN	1794	1788
1972	APR	1800	1794
1972	JUL	1806	1800
1972	OCT	1812	1806
1972	JAN	1818	1812
1972	APR	1824	1818
1972	JUL	1830	1824
1972	OCT	1836	1830
1972	JAN	1842	1836
1972	APR	1848	1842
1972	JUL	1854	1848
1972	OCT</		

FIGURE 27

ULTIMATE FLOWGATION (PERCENT OF INITIAL VALUE) PLASTIC 7 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)

INITIAL VALUE = 198.0%

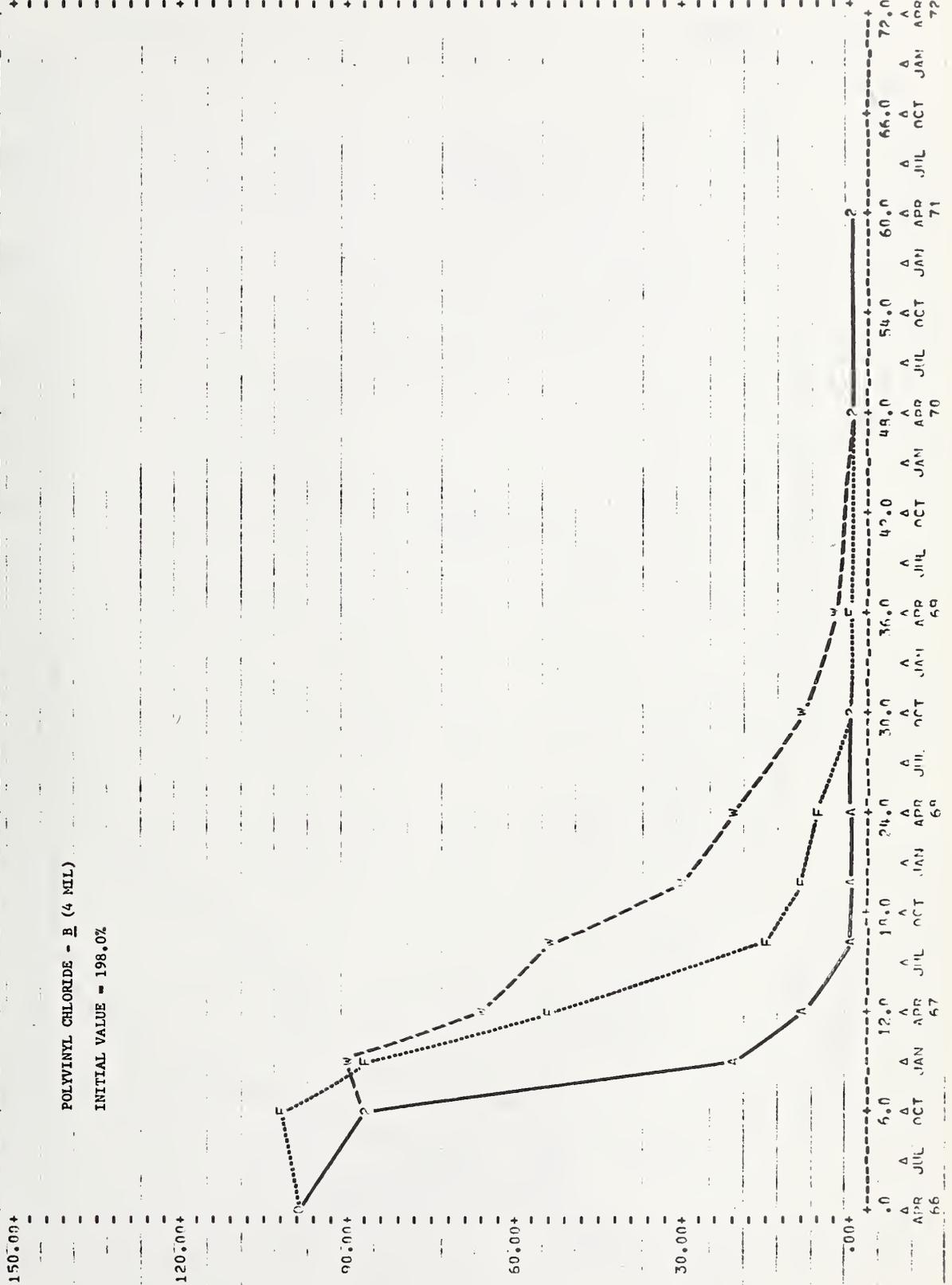


FIGURE 28

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC A=ALABAMA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - B (10 MIL)

INITIAL VALUE = 203.0%

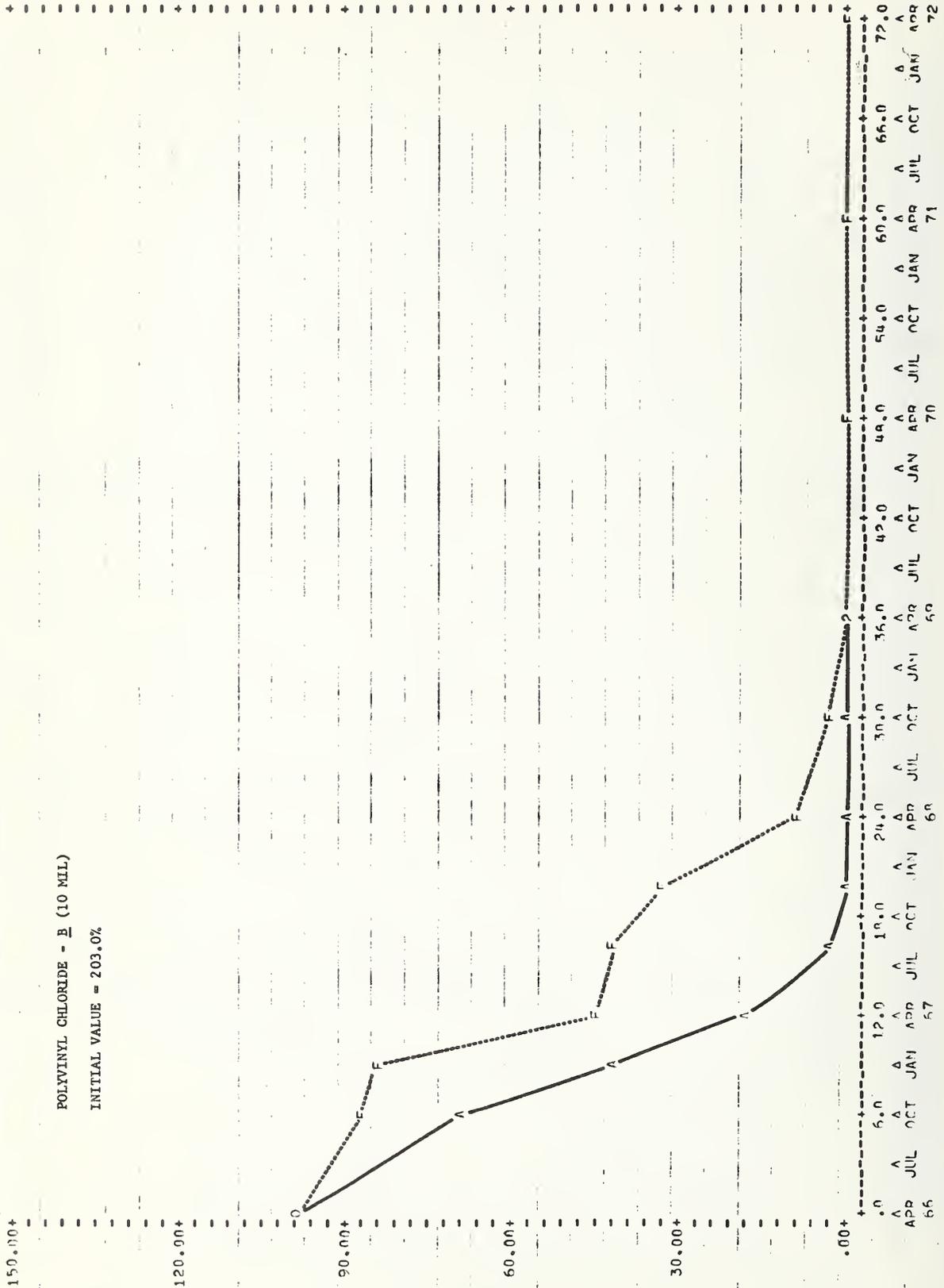


FIGURE 30

ULTIMATE FLOCCULATION (PERCENT OF INITIAL VALUE) PLASTIC 10

FLORIDA WASHINGTON

ARIZONA

POLYVINYL CHLORIDE - 0 (4 MIL)

INITIAL VALUE = 91.0%

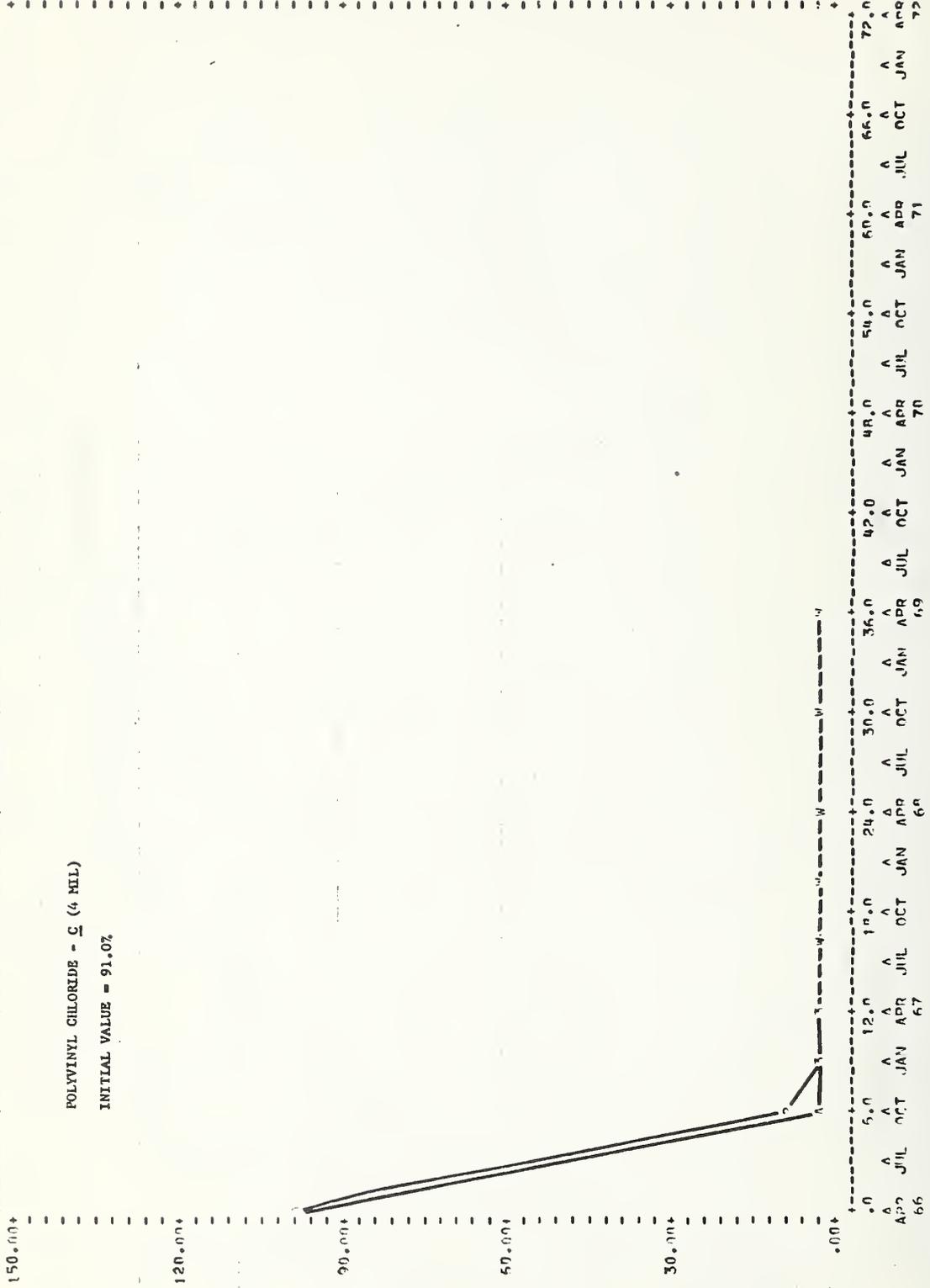


FIGURE 31

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 11

150.00+

POLYVINYL CHLORIDE - C (10 ML)

INITIAL VALUE = 21.7%

120.00+

90.00+

60.00+

30.00+

0.00+

ARIZONA FLORIDA WASHINGTON

PLASTIC 11

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE)

0.00+ 6.00+ 12.00+ 18.00+ 24.00+ 30.00+ 36.00+ 42.00+ 48.00+ 54.00+ 60.00+ 66.00+ 72.00+
 APR JUL OCT JAN APR
 66 67 68 69 70 71 72



FIGURE 32

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 12

A=ARIZONA F=FLORIDA M=WASHINGTON

POLYVINYL CHLORIDE - C (60 MIL)

INITIAL VALUE = 32.1%

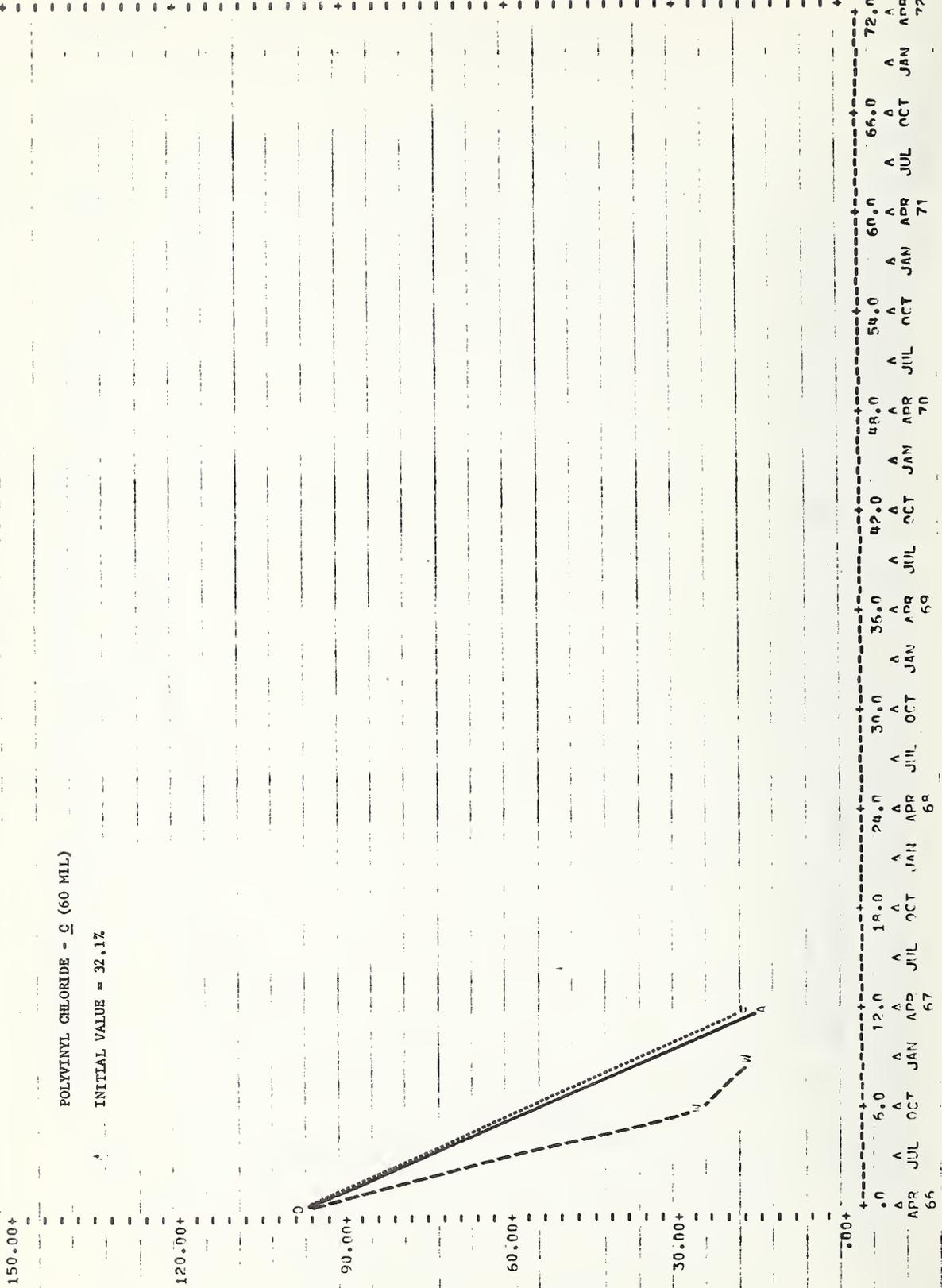
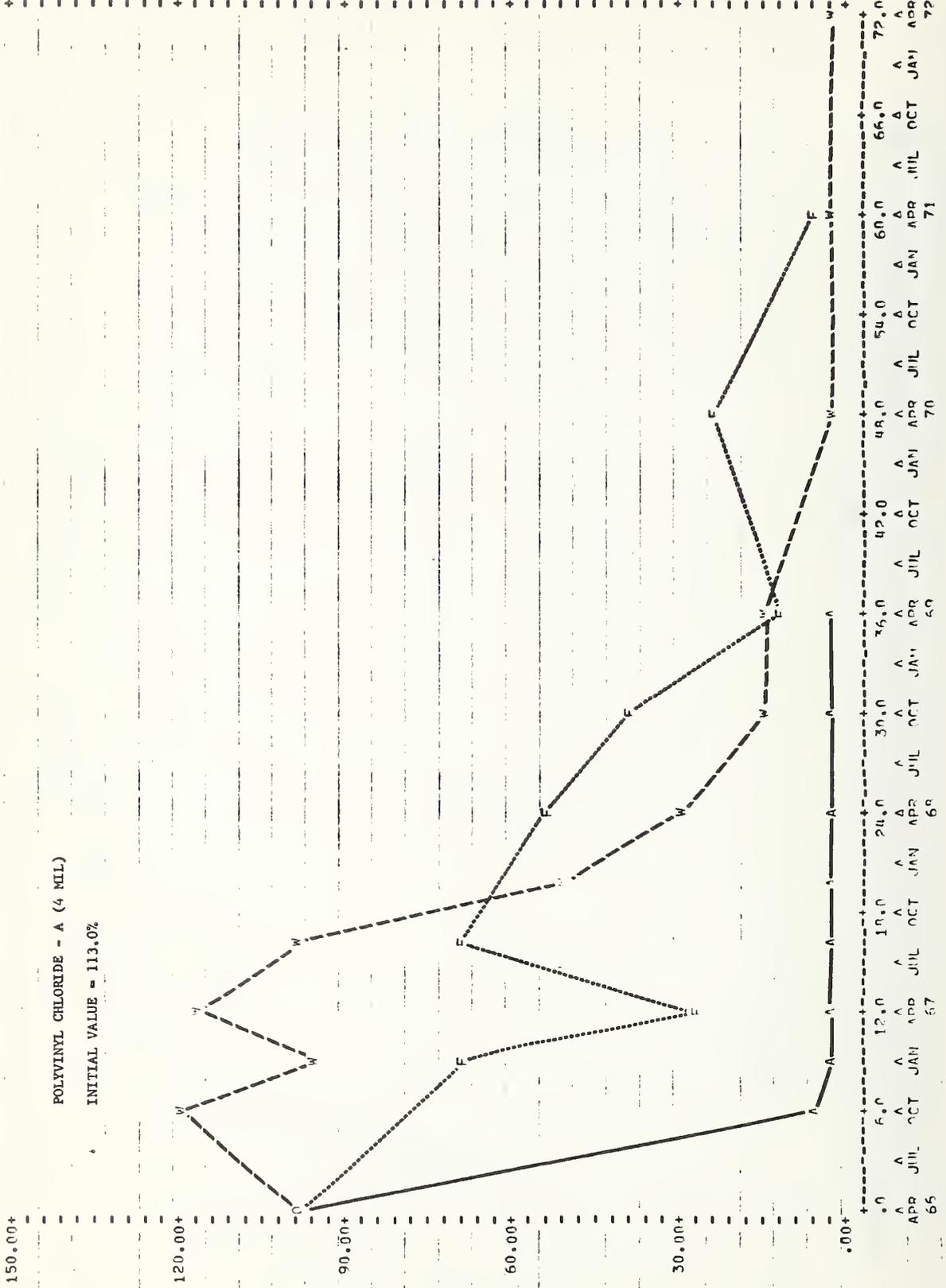


FIGURE 34

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 14 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - A (4 MIL)

INITIAL VALUE = 113.0%



**NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 35

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 15 A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - A (10 MIL)

INITIAL VALUE = 155.0%

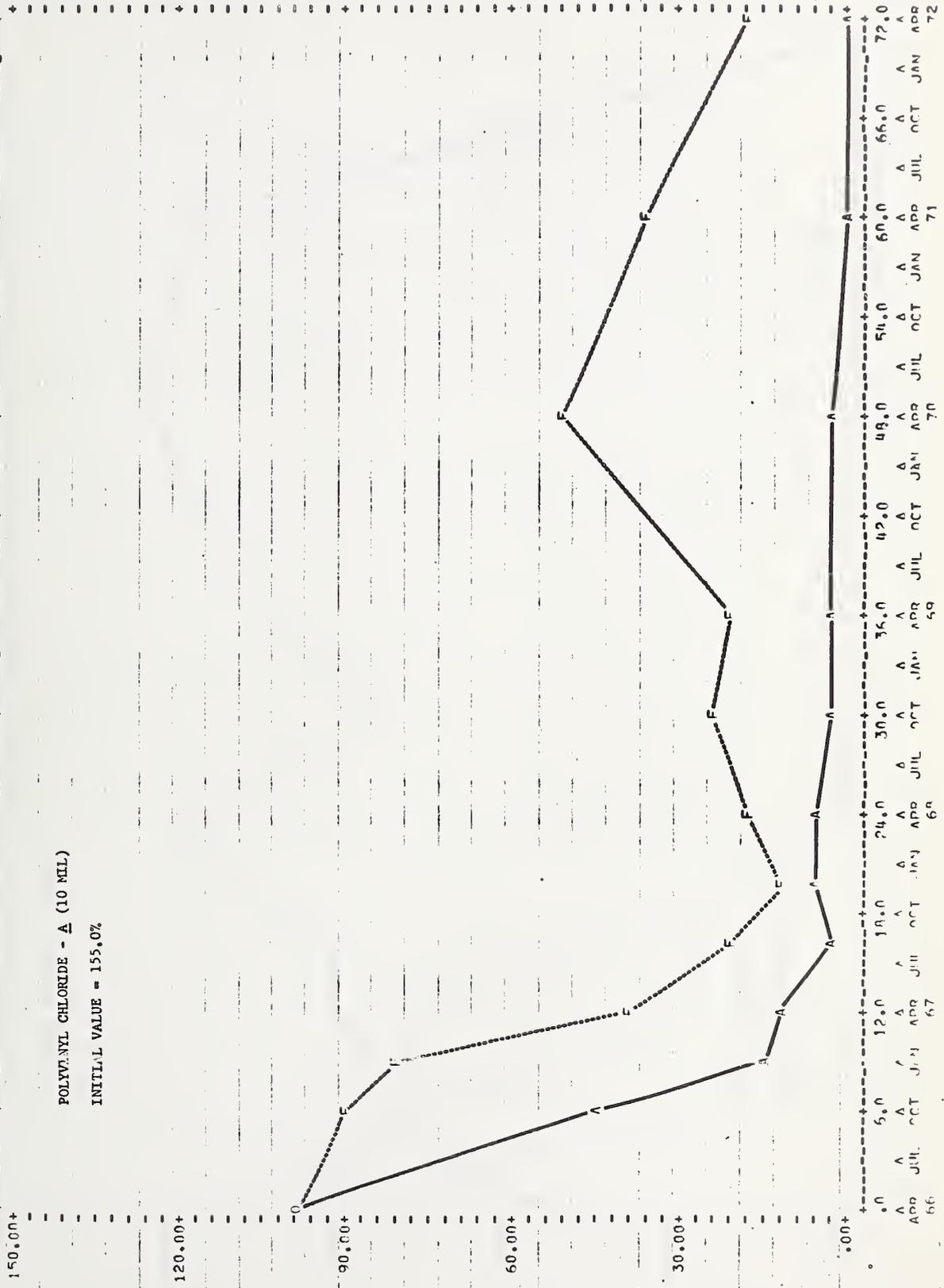


FIGURE 36

ULTIMATE FLOWNATION (PERCENT OF INITIAL VALUE) PLASTIC 14

ARIZONA

FLORIDA

MISSISSIPPI

NEW YORK

WASHINGTON

POLYVINYL CHLORIDE - A (60 MIL)

INITIAL VALUE = 47.8%

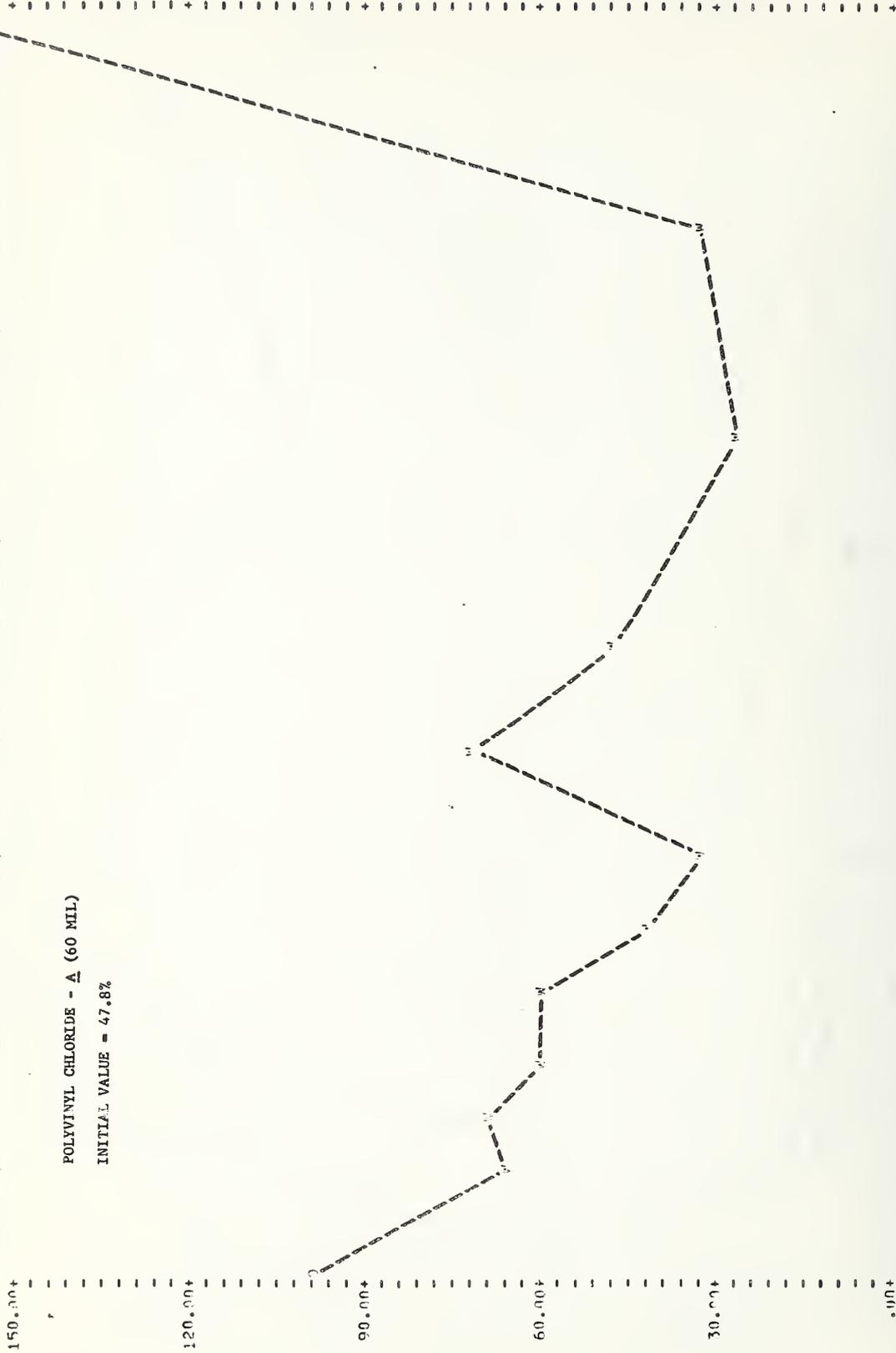


FIGURE 37

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 17 ARIZONA FLORIDA WASHINGTON

150.00+

POLY VINYL CHLORIDE - D (4 MIL)

INITIAL VALUE = 191.0%

120.00+

90.00+

60.00+

30.00+

0.00+

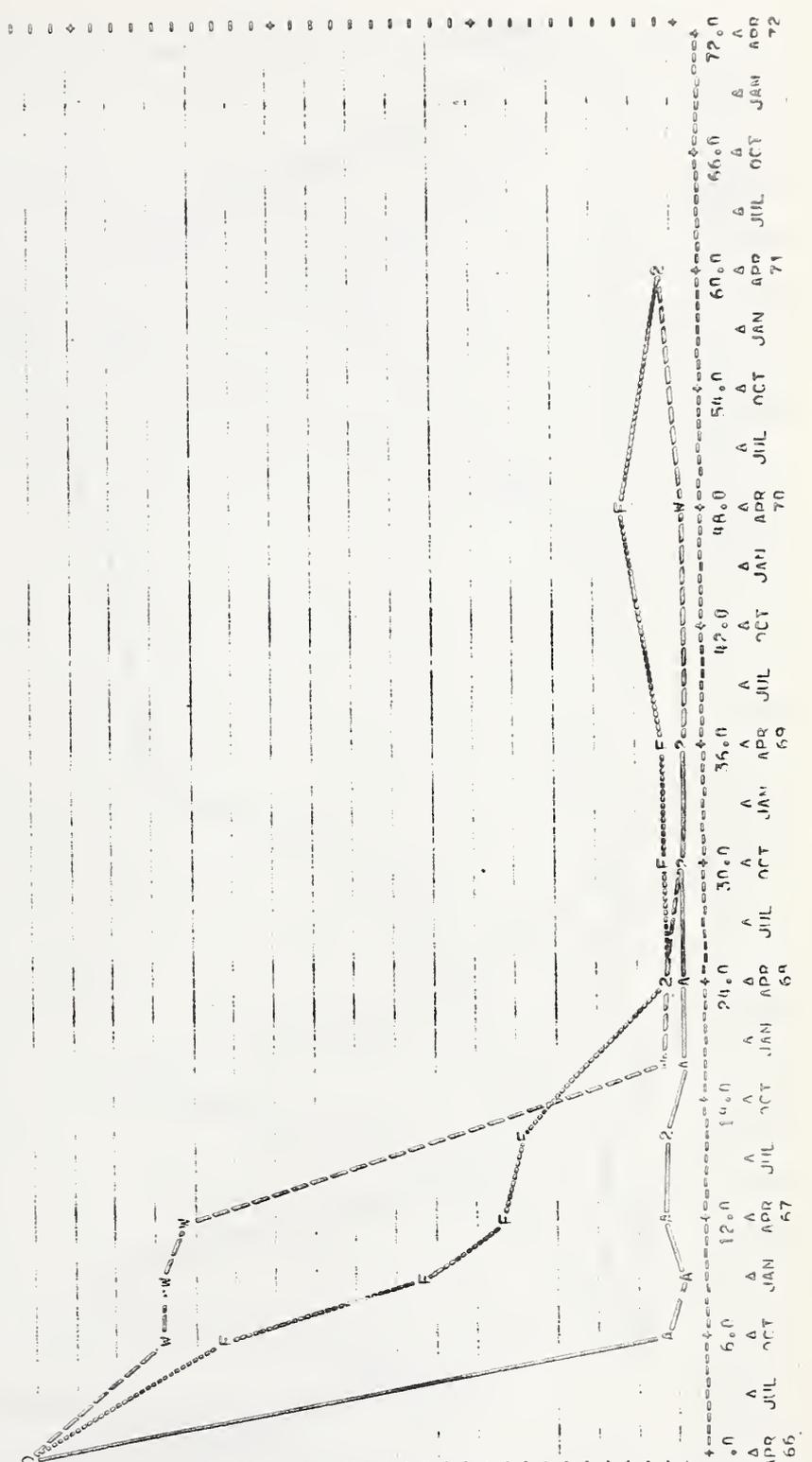


FIGURE 38

ULTIMATE ELONGATION (PERCENT OF INITIAL VALUE) PLASTIC 1A ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - D (10 MIL)

INITIAL VALUE = 142.0%

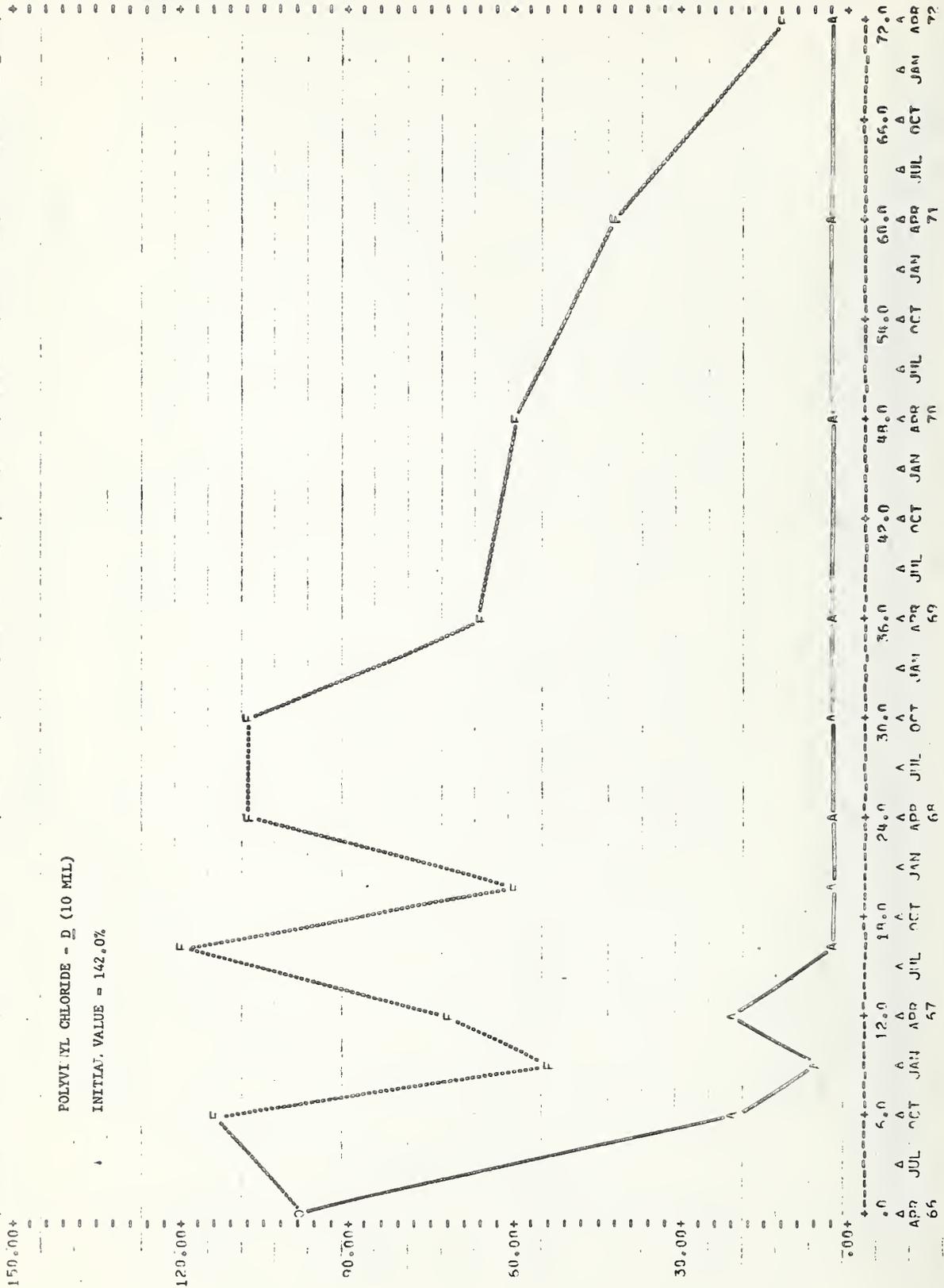


FIGURE 39

ULTIMATE FLOURATION PERCENT OF INITIAL VALUE) PLASTIC 19 ARIZONA FLORIDA WASHINGTON

150.00+

POLYVINYL CHLORIDE - D (60 MIL)

INITIAL VALUE = 50.7%

120.00+

90.00+

60.00+

30.00+

0.00+

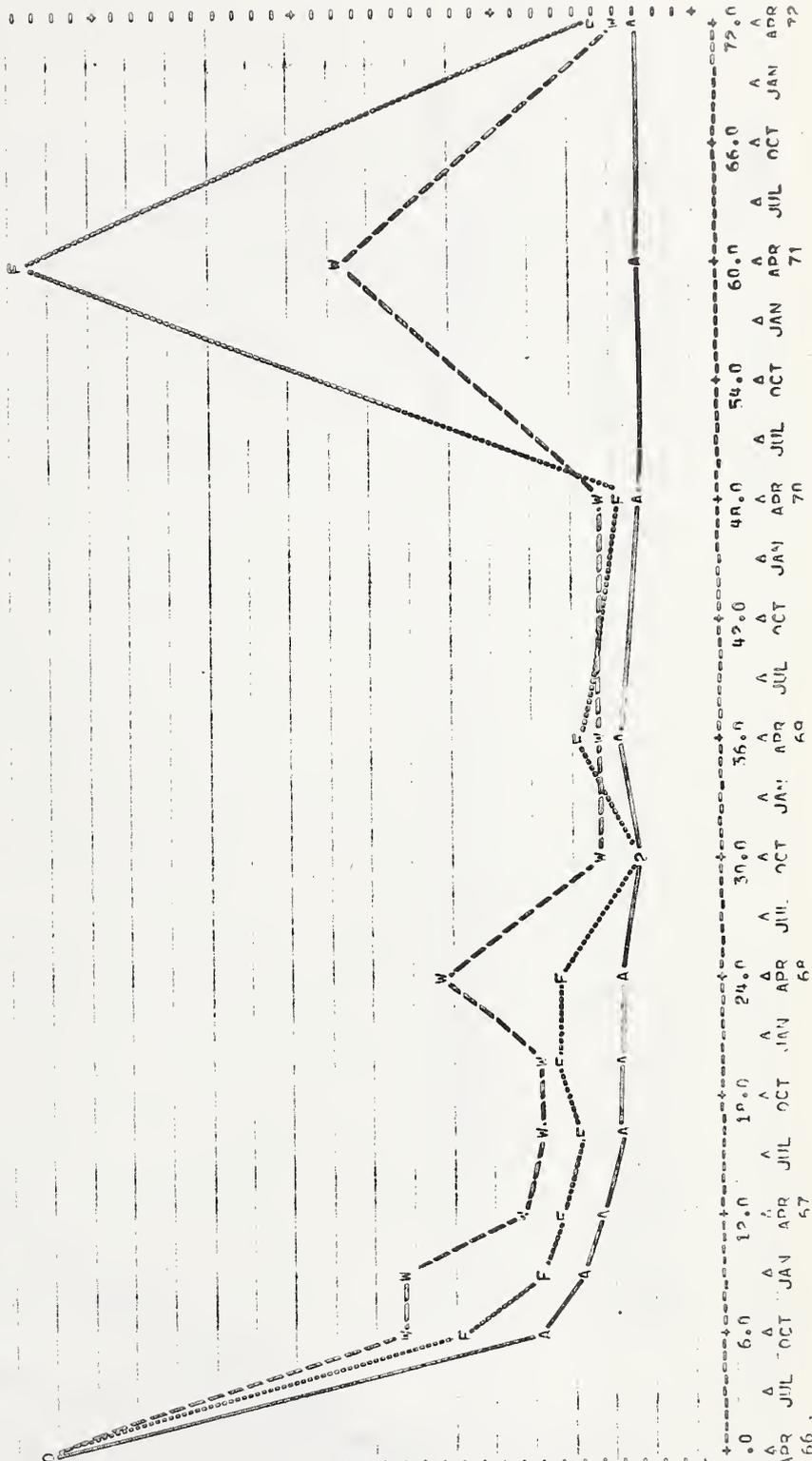


FIGURE 40

ULTIMATE FLOWGATION (PERCENT OF INITIAL VALUE) PLASTIC NO. WASHINGTON WASHINGTON WASHINGTON

POLYVINYL CHLORIDE - M (60 MIL)

INITIAL VALUE = 178.0%

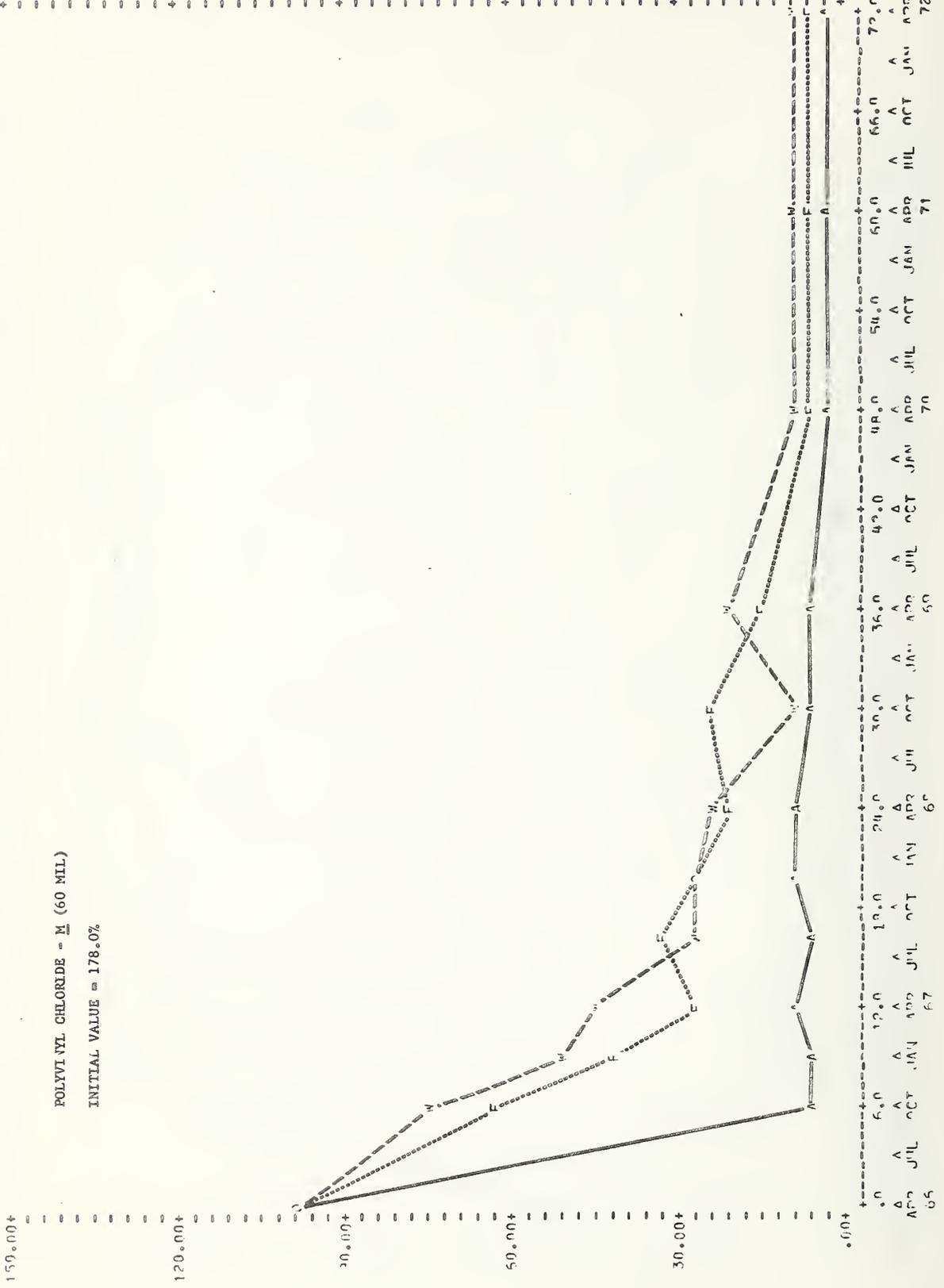


FIGURE 41

5 PERCENT STRESS (PSI) PLASTIC 2 ARIZONA FLORIDA WASHINGTON

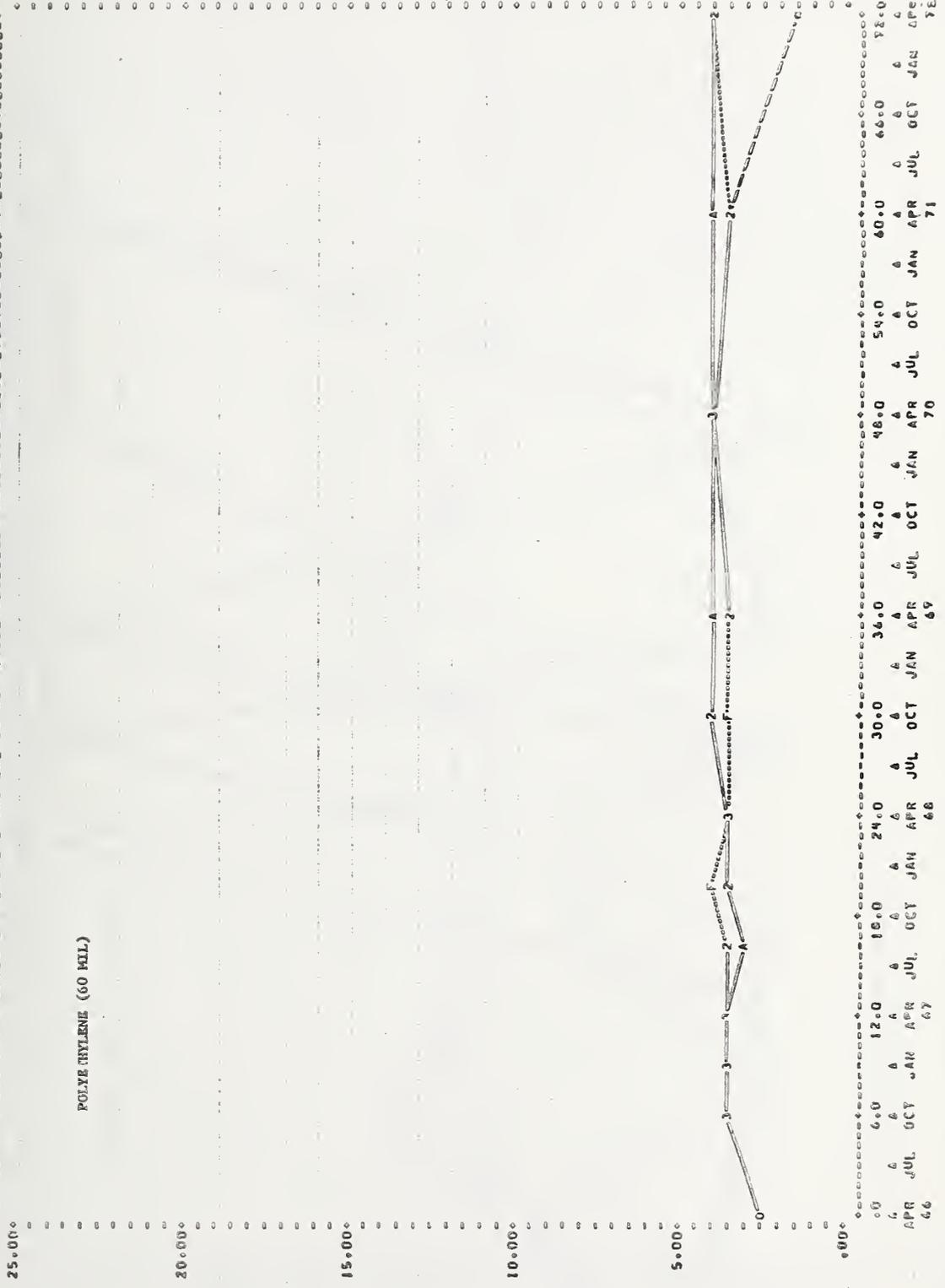


FIGURE 42

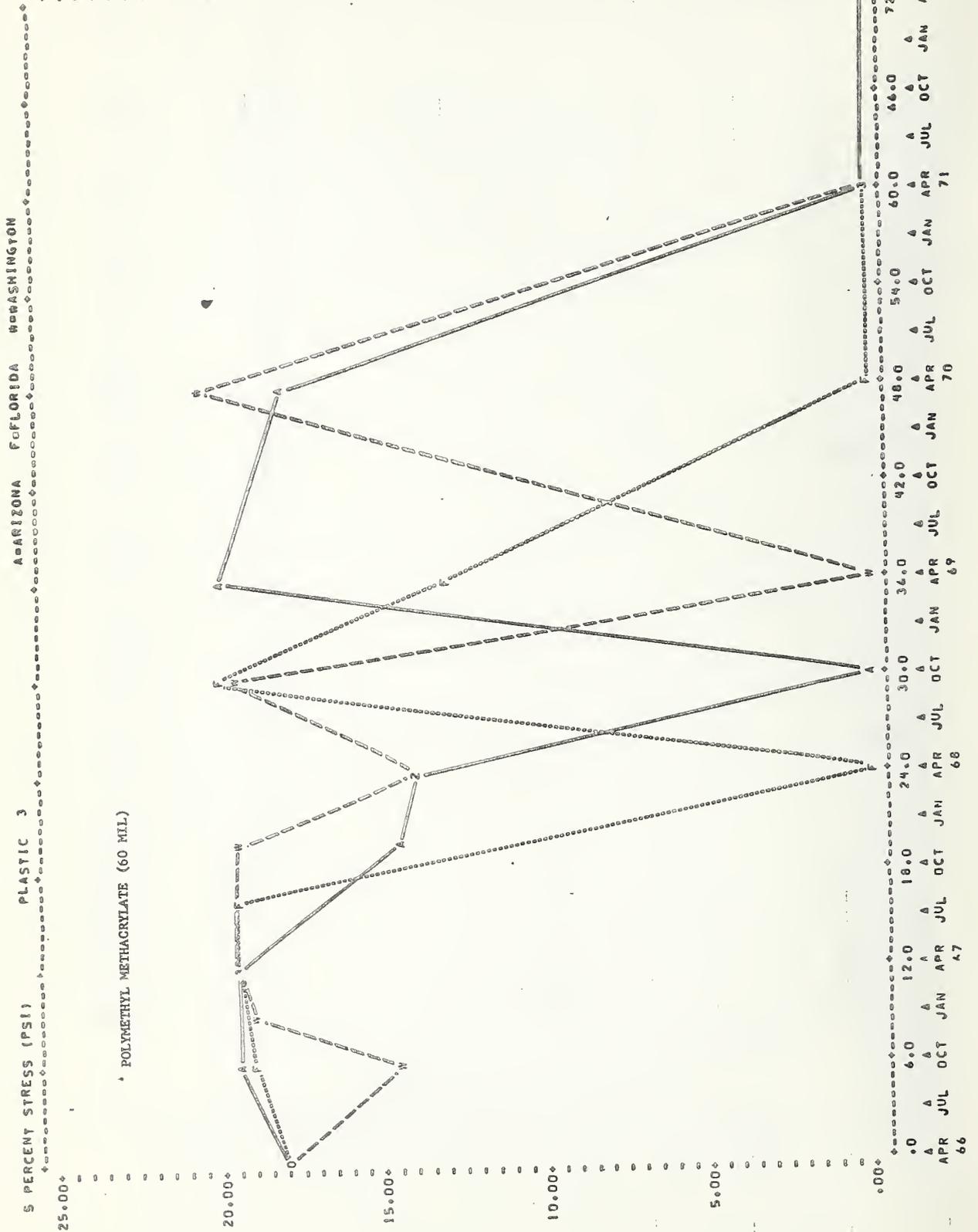
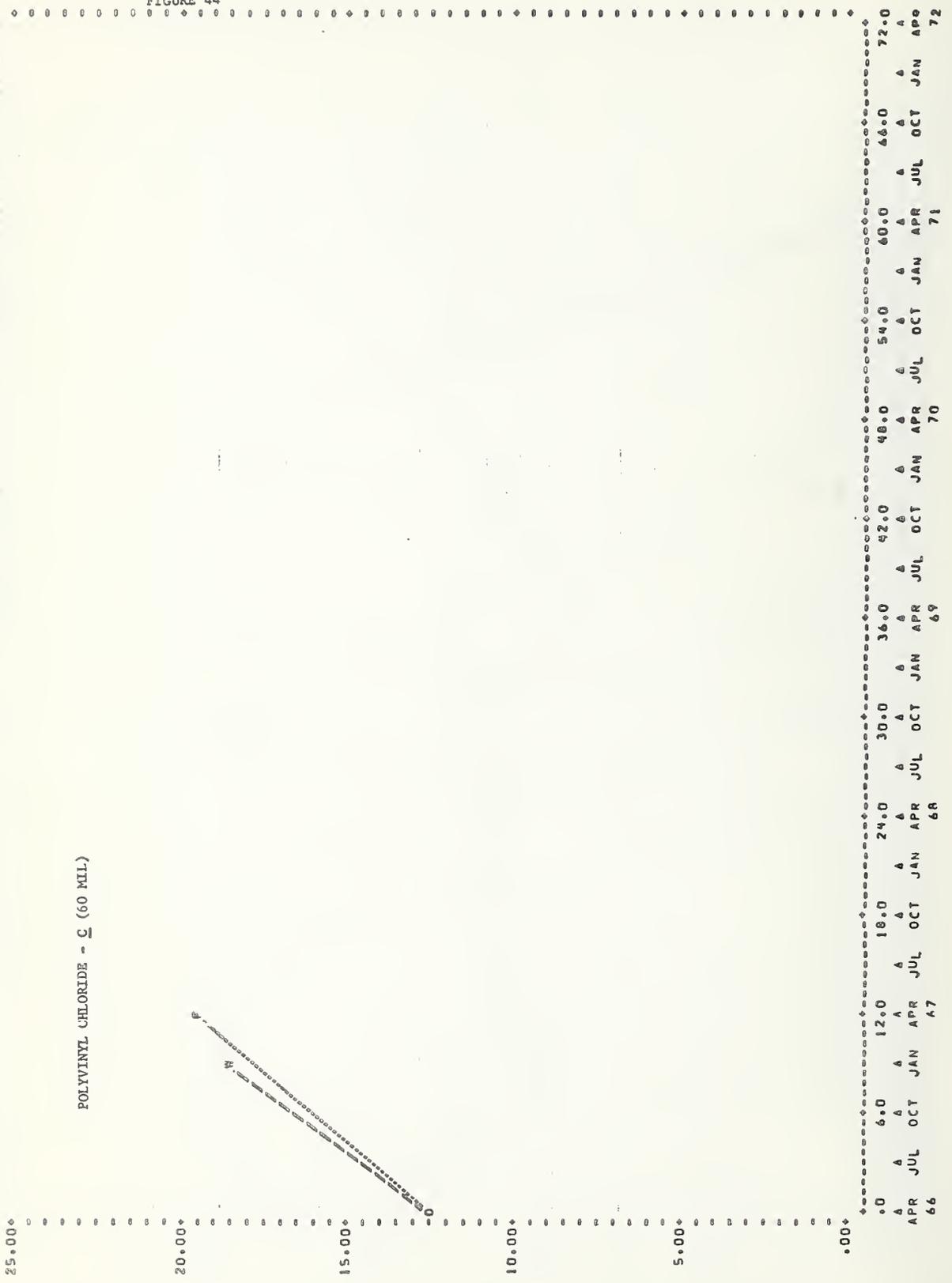


FIGURE 44

5 PERCENT STRESS (PSI) PLASTIC 12 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - C (60 MIL)



5 PERCENT STRESS (PSI) PLASTIC 16 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - A (60 MIL)

FIGURE 46

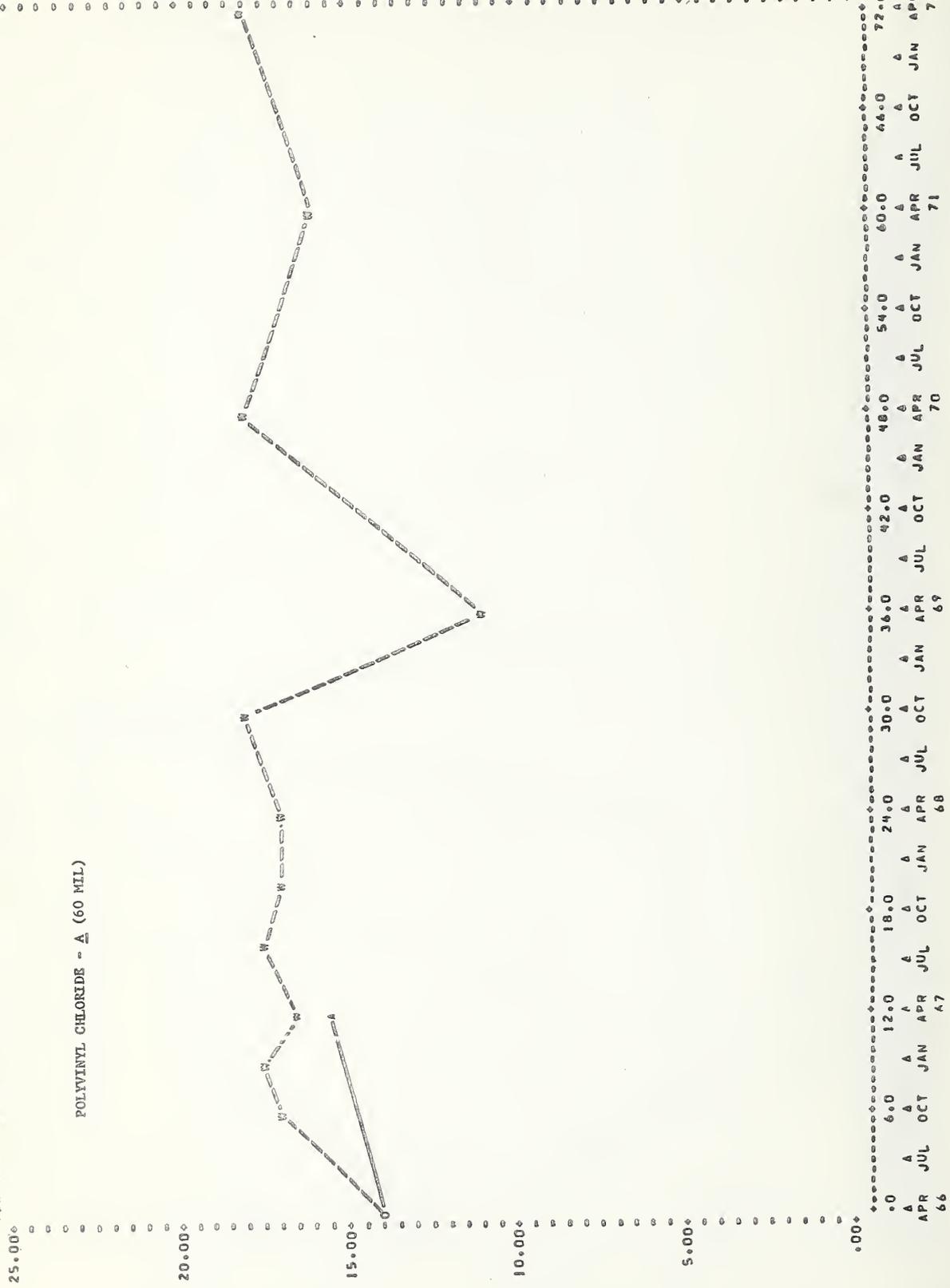
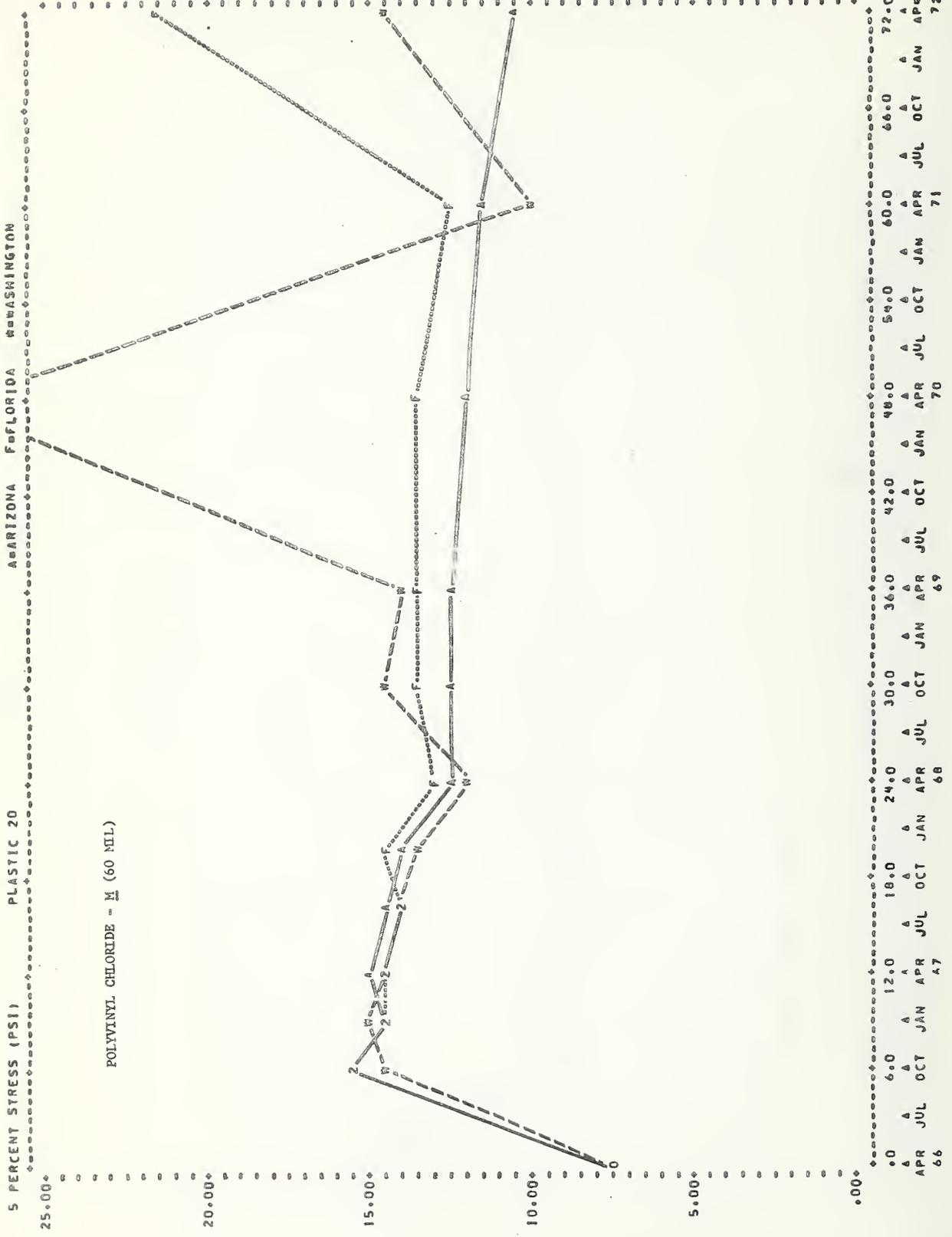


FIGURE 48



NOTE. 1 POINTS FELL OUTSIDE THE SPECIFIED LIMITS AND WERE OMITTED.

FIGURE 52

GLOSS (IN PERCENT) PLASTIC " ARIZONA FLORIDA WASHINGTON

POLYVINYL FLUORIDE (1 MIL)

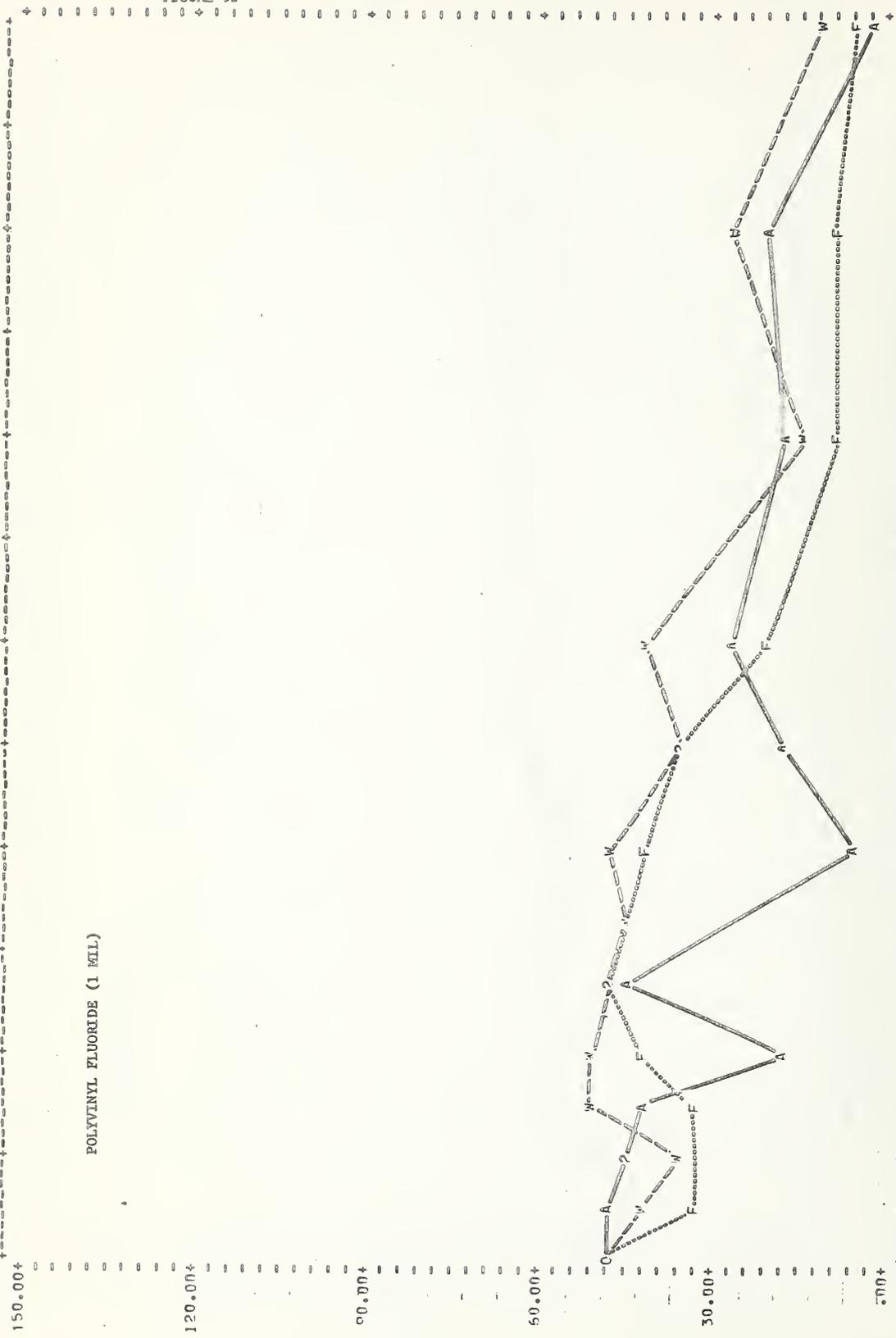
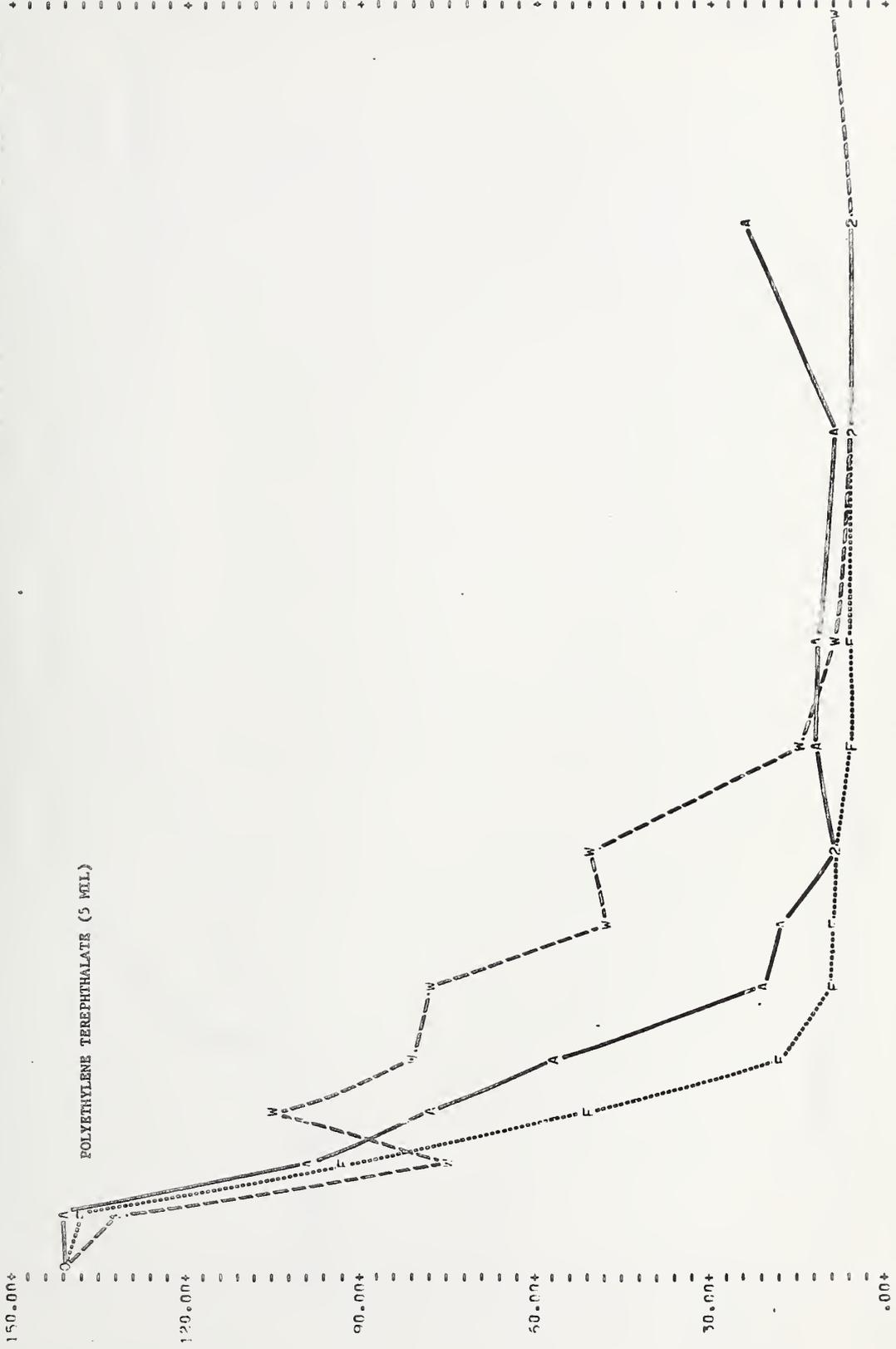


FIGURE 53

GLASS (IN PERCENT) PLASTIC ARIZONA FLORIDA WASHINGTON



150.00+
120.00+
90.00+
60.00+
30.00+
0.00+

65
64
63
62
61
60
59
58
57
56
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53
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11
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9
8
7
6
5
4
3
2
1

FIGURE 54

WASHINGTON

FLORIDA

ARIZONA

PLASTIC

GLASS (IMPERFECT)

GLASS-REINFORCED POLYESTER (60 MIL)

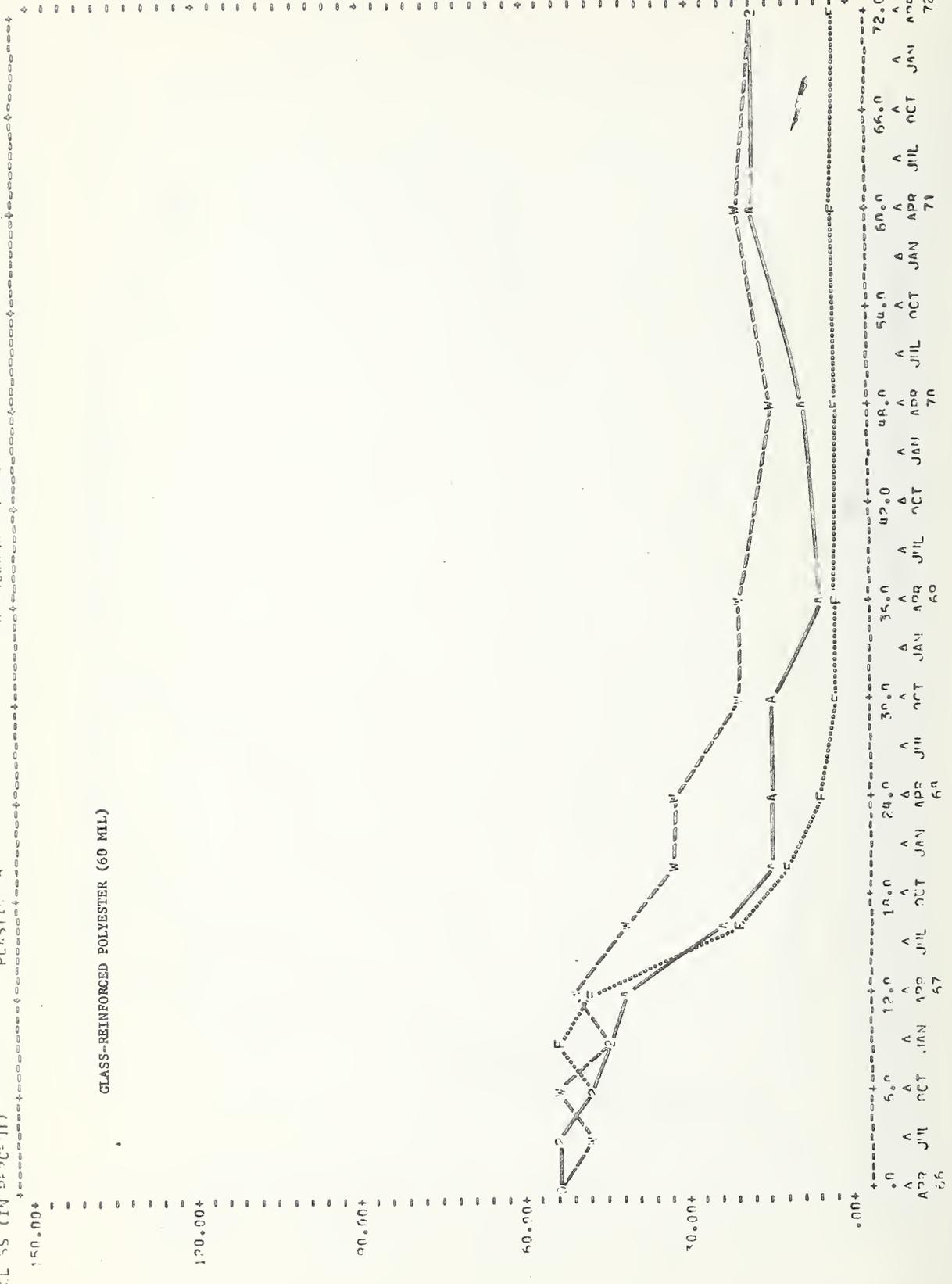


FIGURE 55

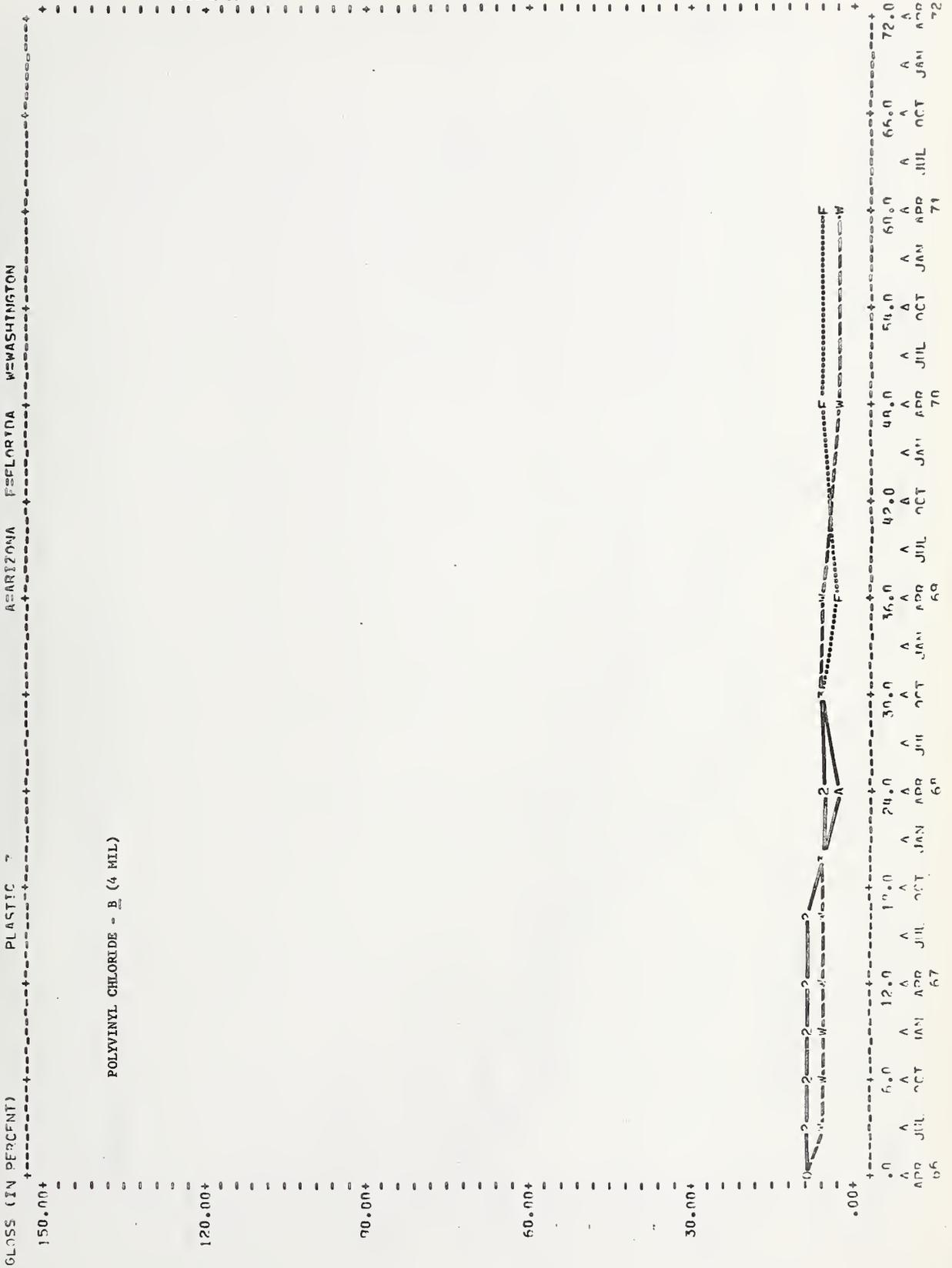


FIGURE 57

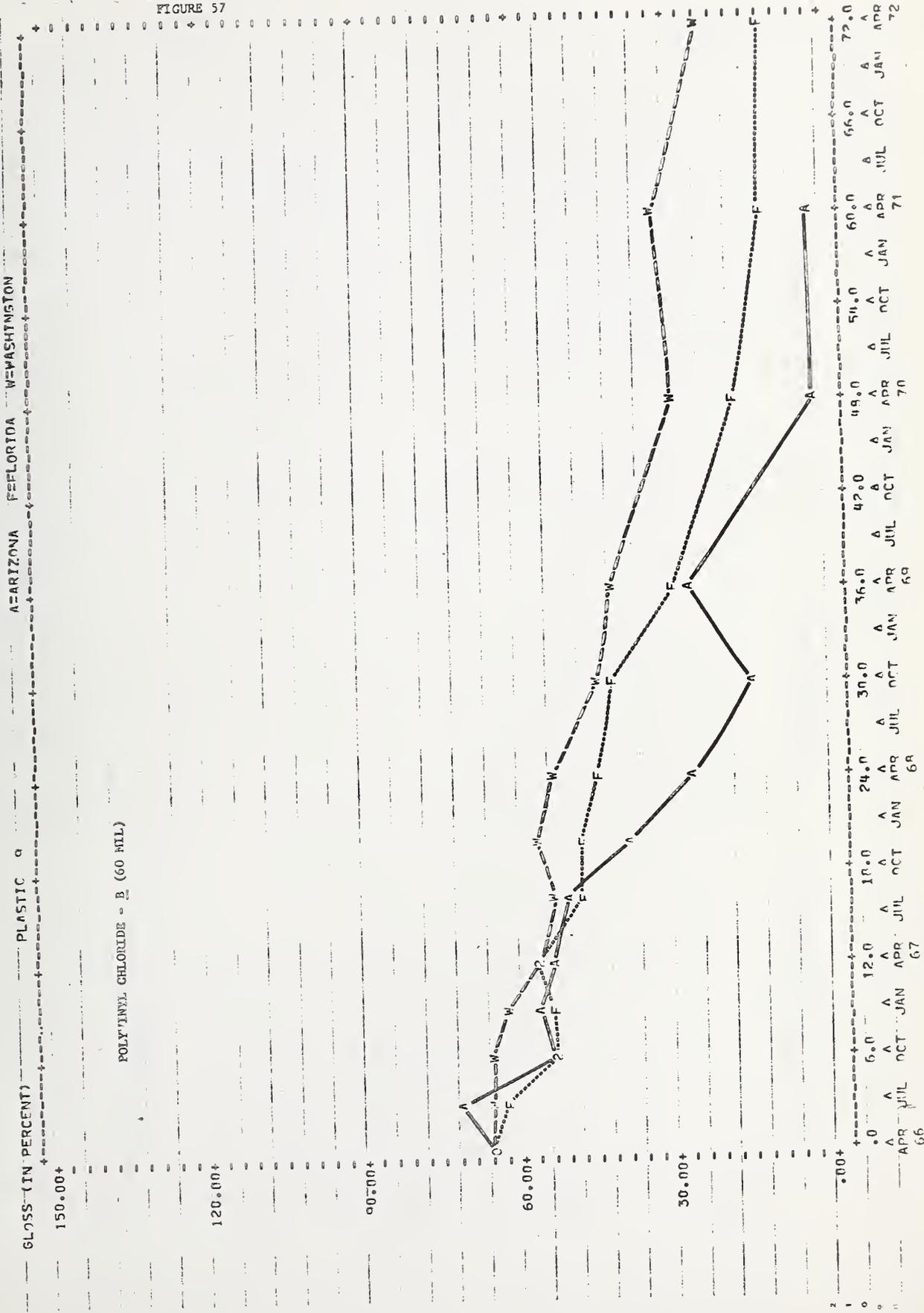


FIGURE 58

ARIZONA FLORIDA WASHINGTON

PLASTIC 10

POLYVINYL CHLORIDE - C (4 MIL)

GLOSS (IN PERCENT)
 150.00+
 120.00+
 90.00+
 60.00+
 30.00+
 0.00+

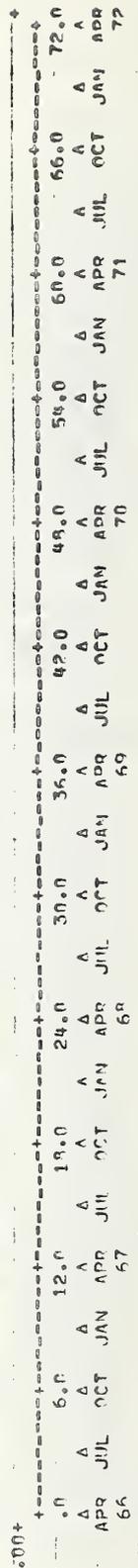


FIGURE 59

GLASS (IN PERCENT) PLASTIC 1³ ARIZONA FLORIDA WASHINGTON

150.00+

POLYVINYL CHLORIDE - C (10 MIL)

120.00+

90.00+

60.00+

30.00+

0.00+

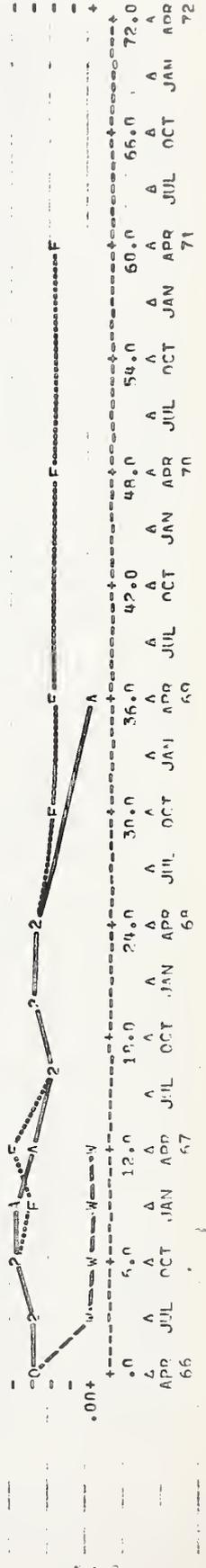


FIGURE 60

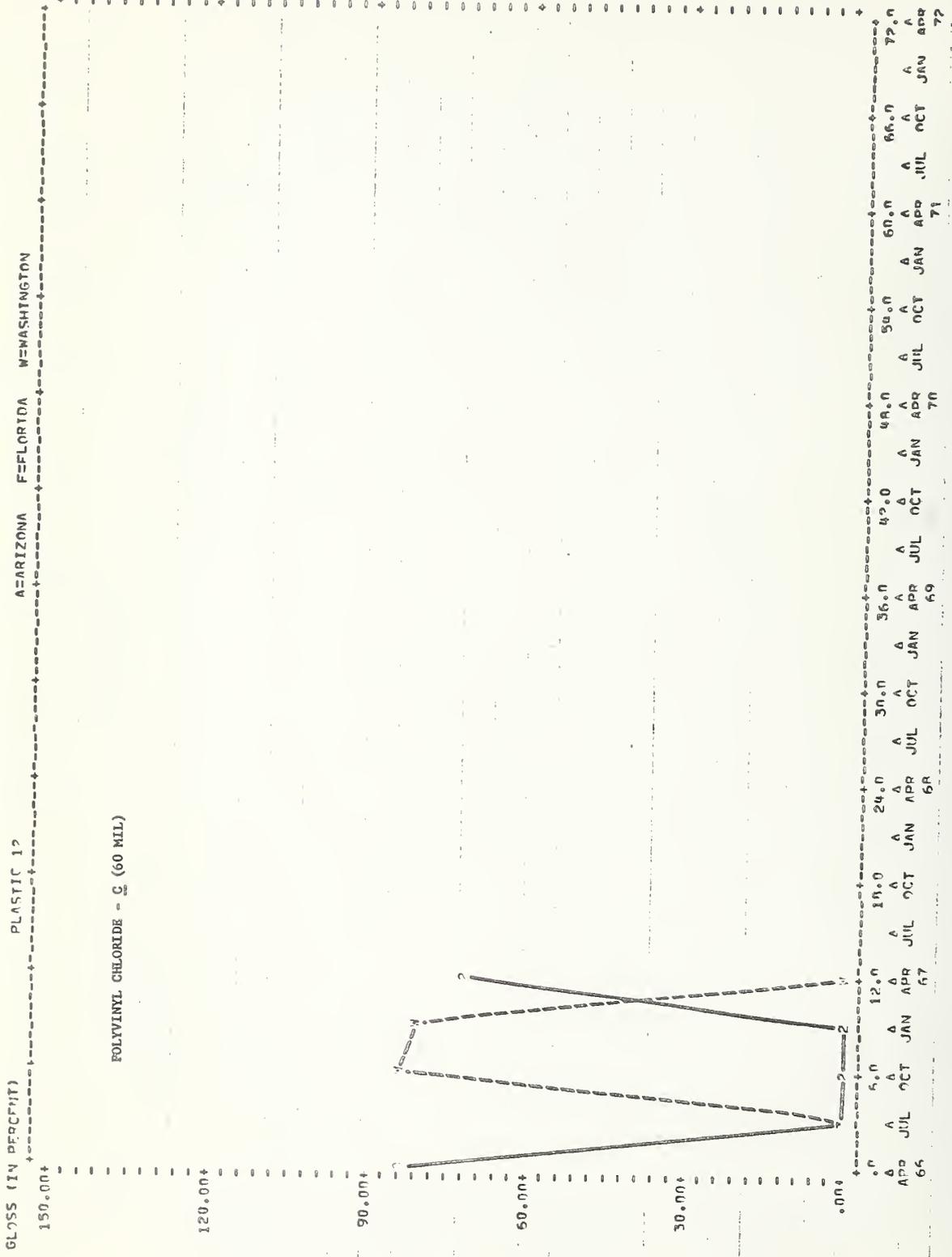


FIGURE 61

GLASS (IN PERCENT) PLASTIC 13 ARIZONA FLORIDA WASHINGTON

150.00+

POLYVINYL CHLORIDE - N (60 MEL)

120.00+

90.00+

60.00+

30.00+

0.00+

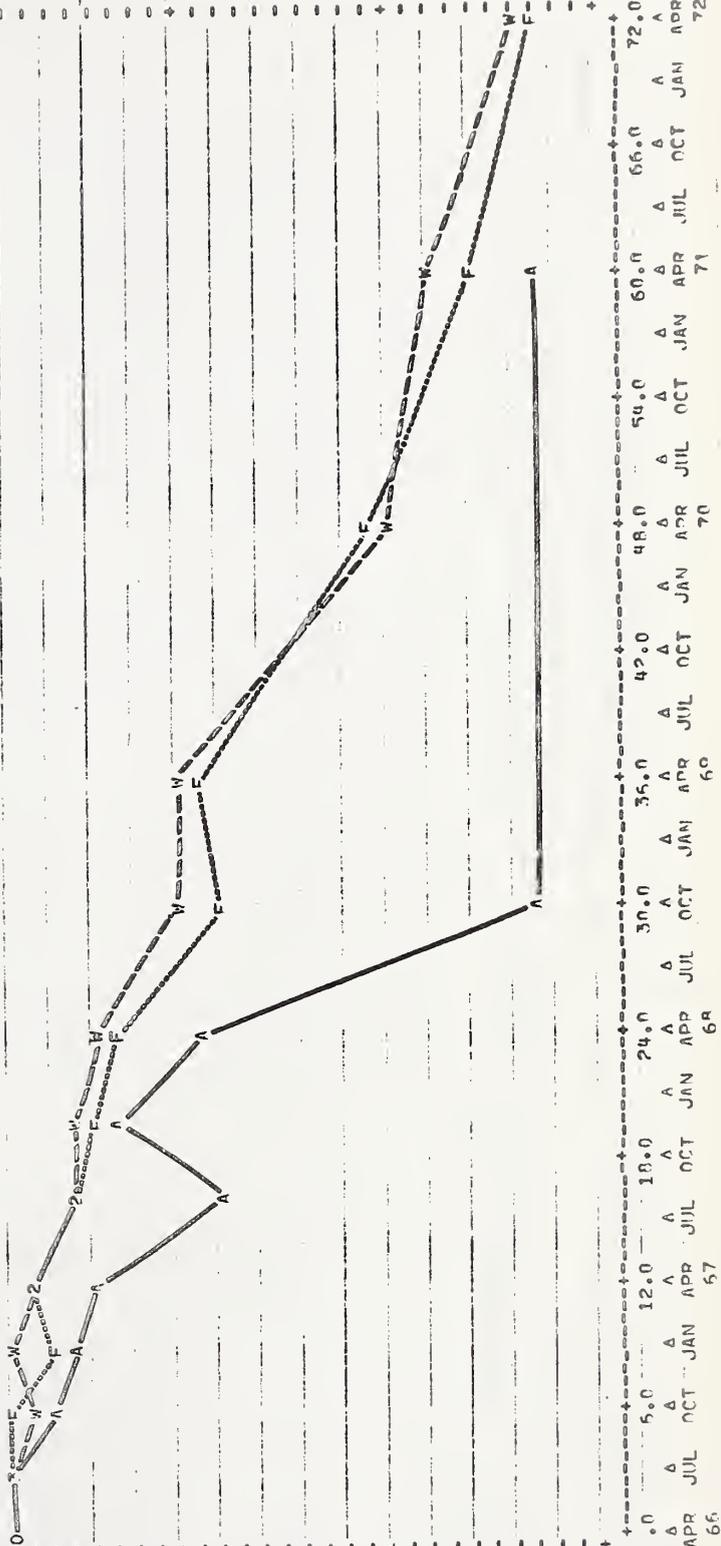
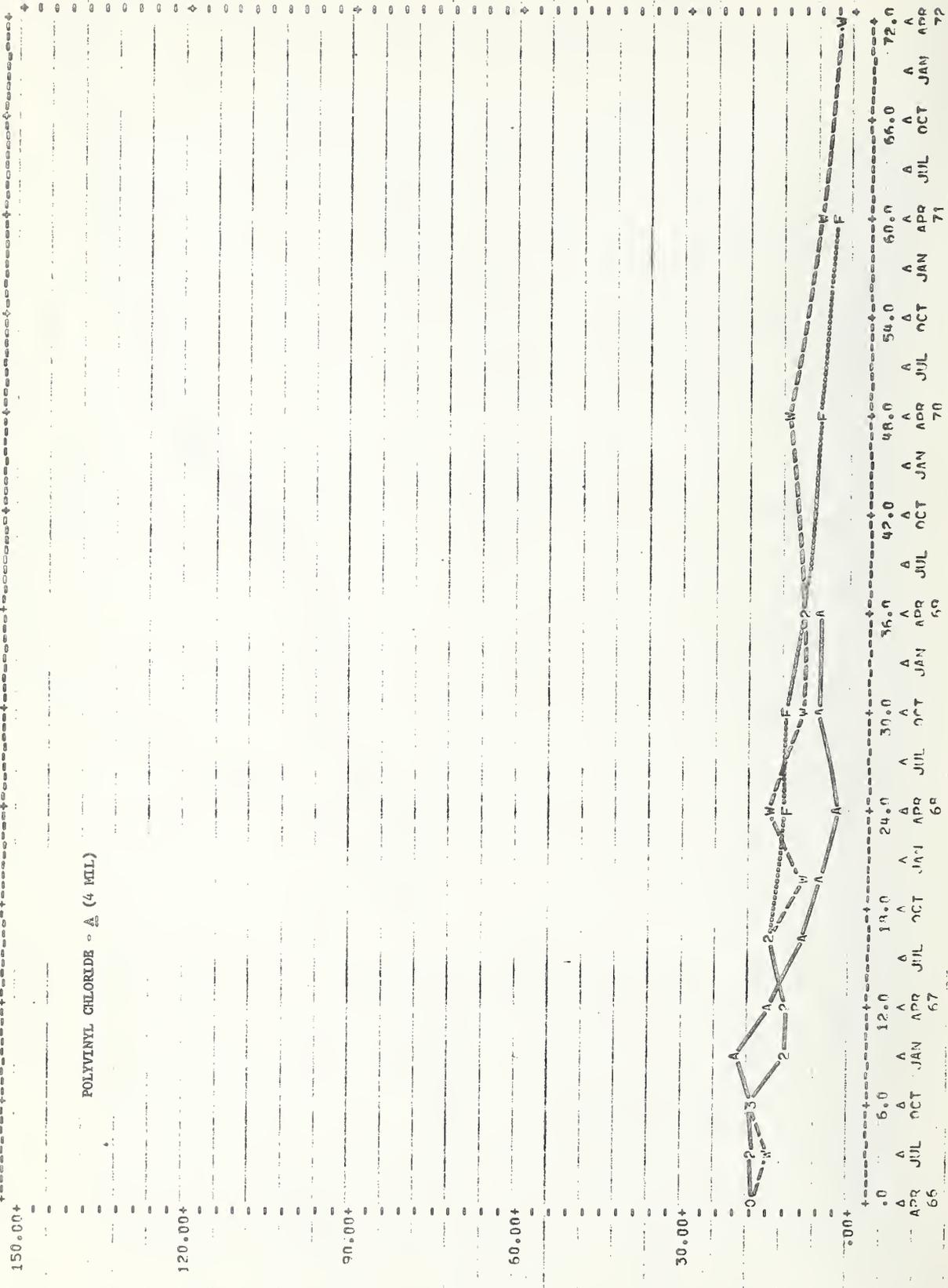


FIGURE 62

GLOSS (IN PERCENT) PLASTIC 14 ARIZONA FLORIDA WASHINGTON



POLYVINYL CHLORIDE - A (4 MIL)

150.00+

120.00+

90.00+

60.00+

30.00+

0.00+

FIGURE 63

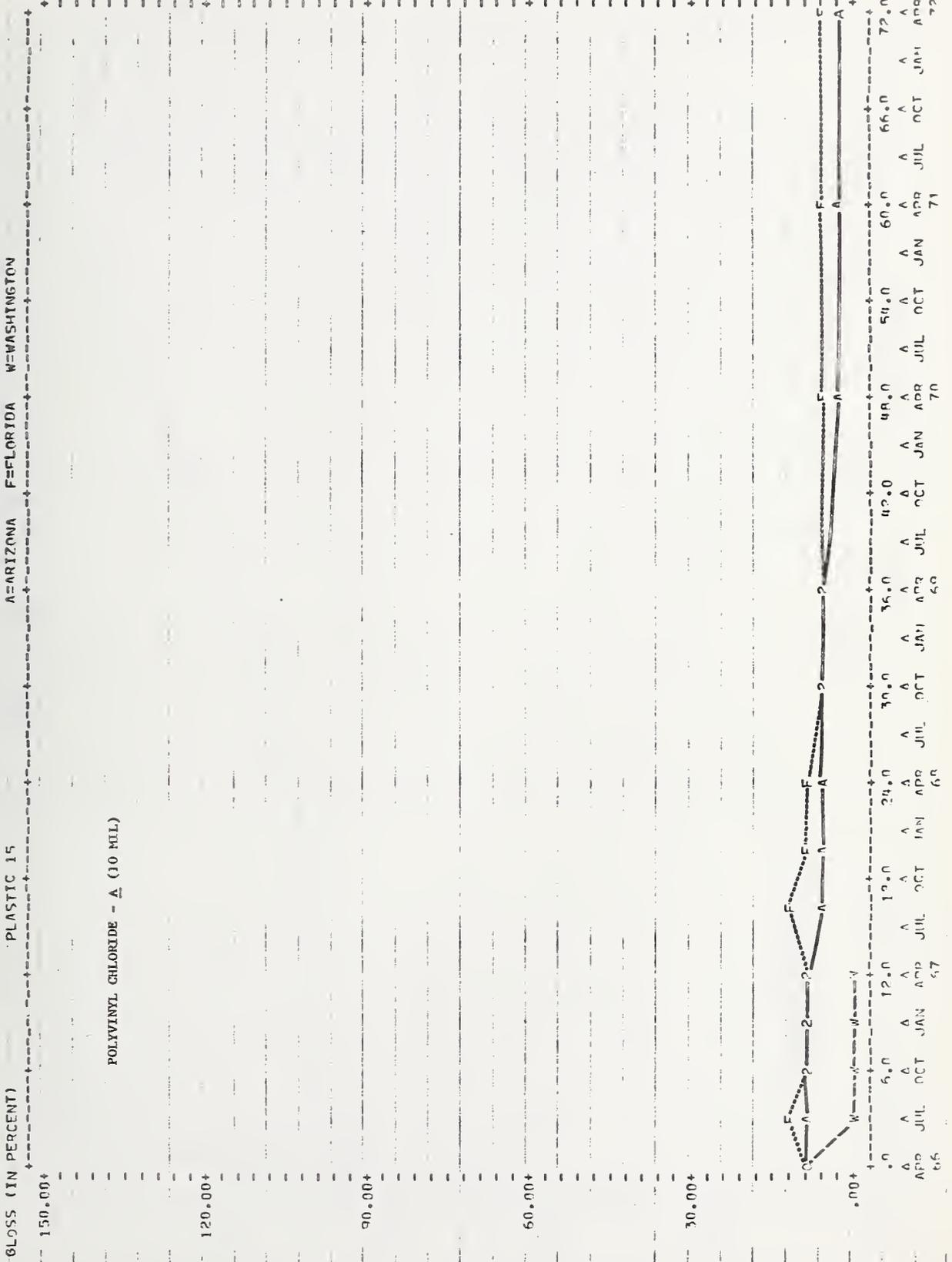
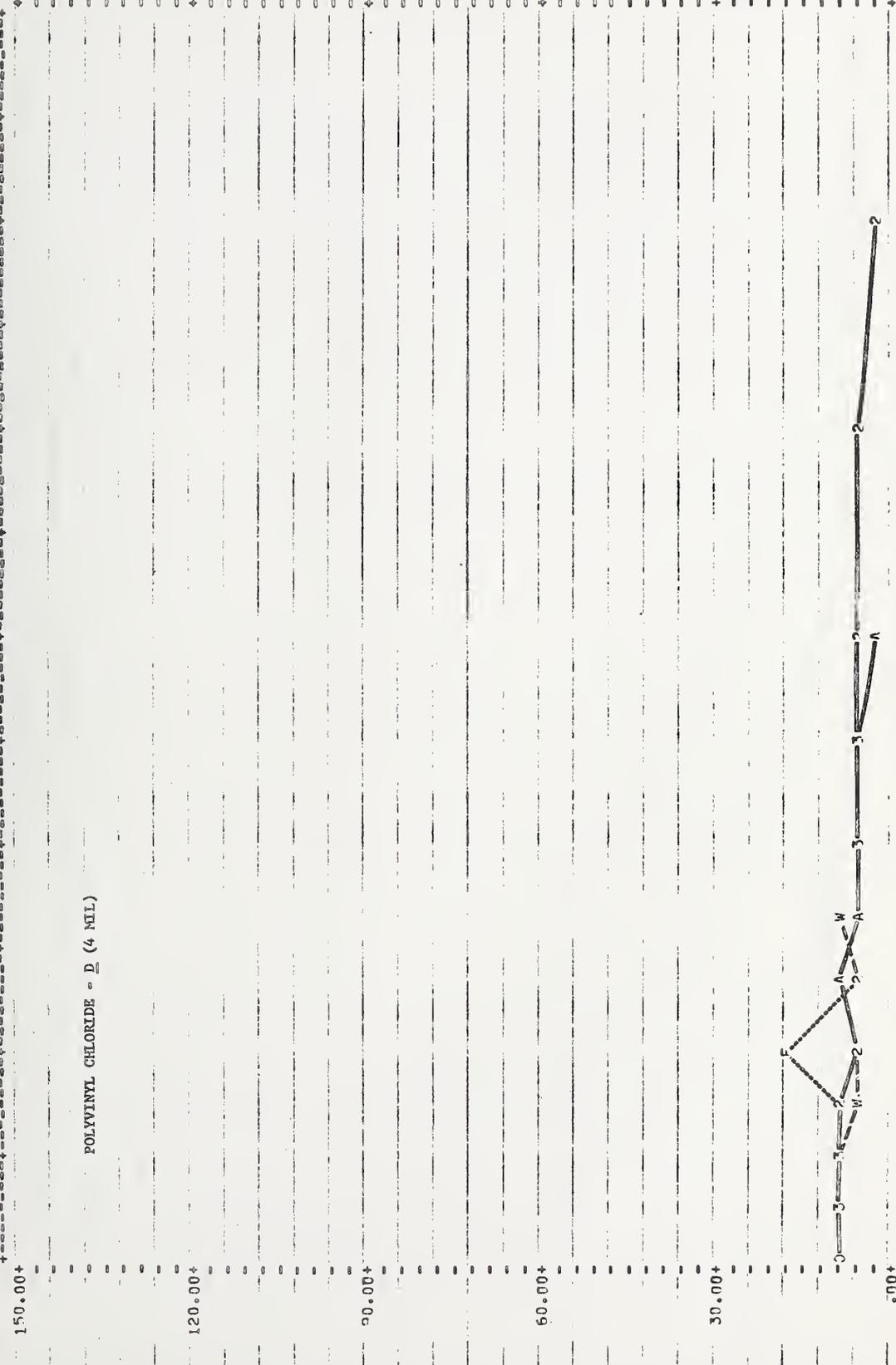


FIGURE 65

PLASTIC 17 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - D (4 MIL)



150.00+
120.00+
90.00+
60.00+
30.00+
0.00+

0 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 72

APR JUL OCT JAN APR

67 68 69 70 71 72

FIGURE 66

ARIZONA FLORIDA WASHINGTON

PLASTIC 10

GLOSS (IN PERCENT)

POLYVINYL CHLORIDE - D (10 MLL)

150.00+

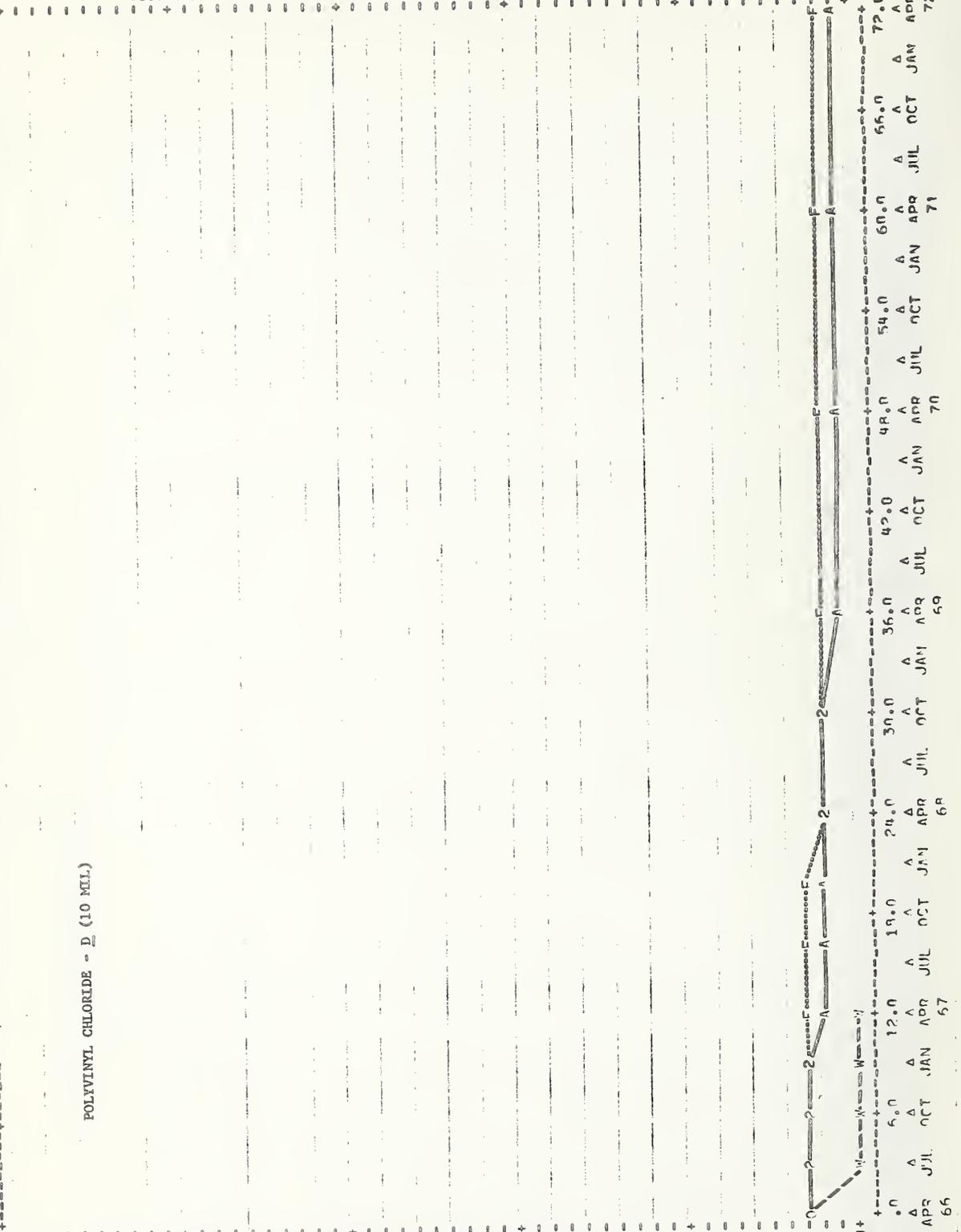
120.00+

90.00+

50.00+

30.00+

0.00+



65

67

68

69

70

71

72

FIGURE 68

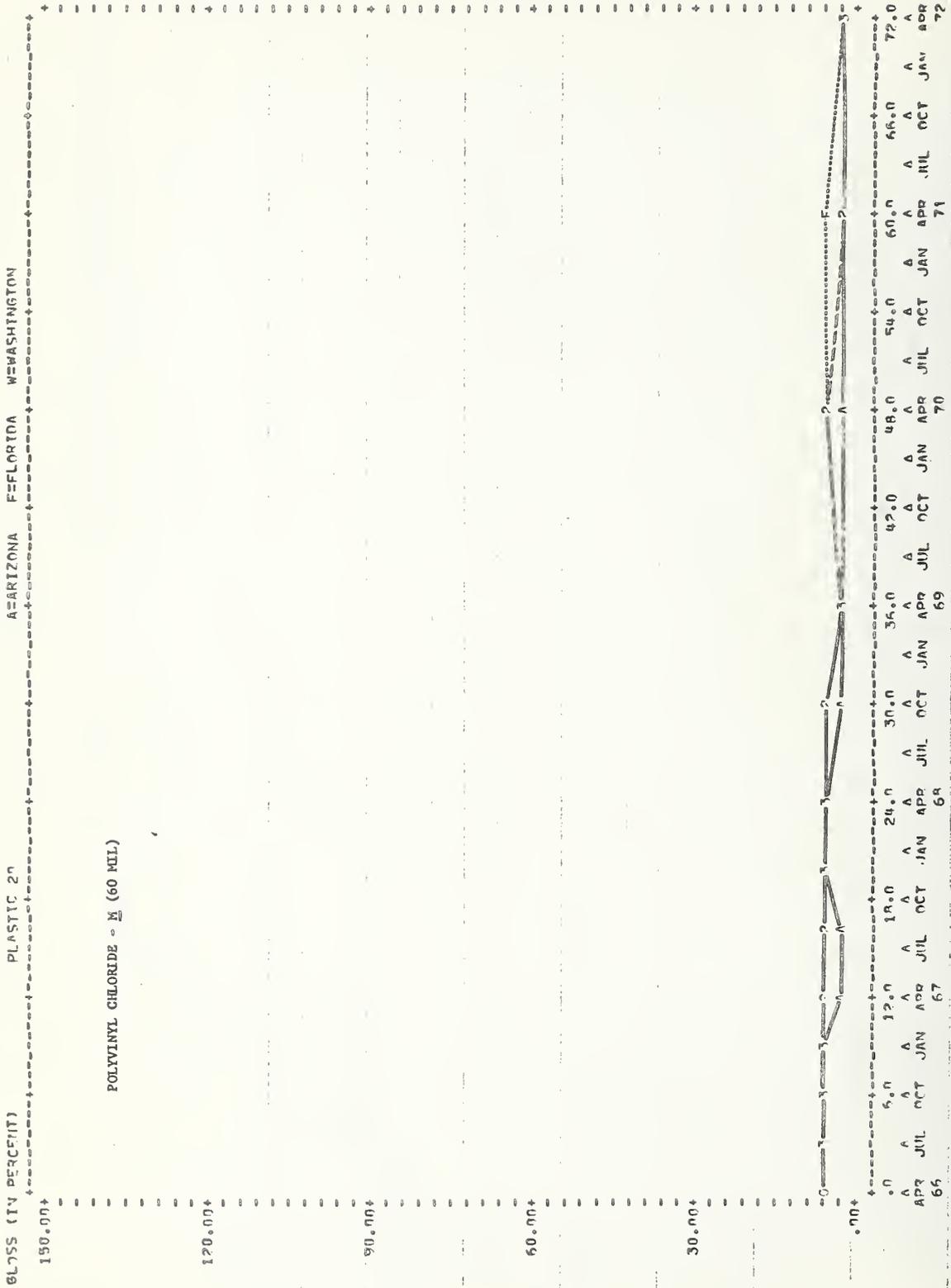


FIGURE 69A

HAZE AT 420NM (IN PERCENT) PLASTIC I ARIZONA FLORIDA WASHINGTON

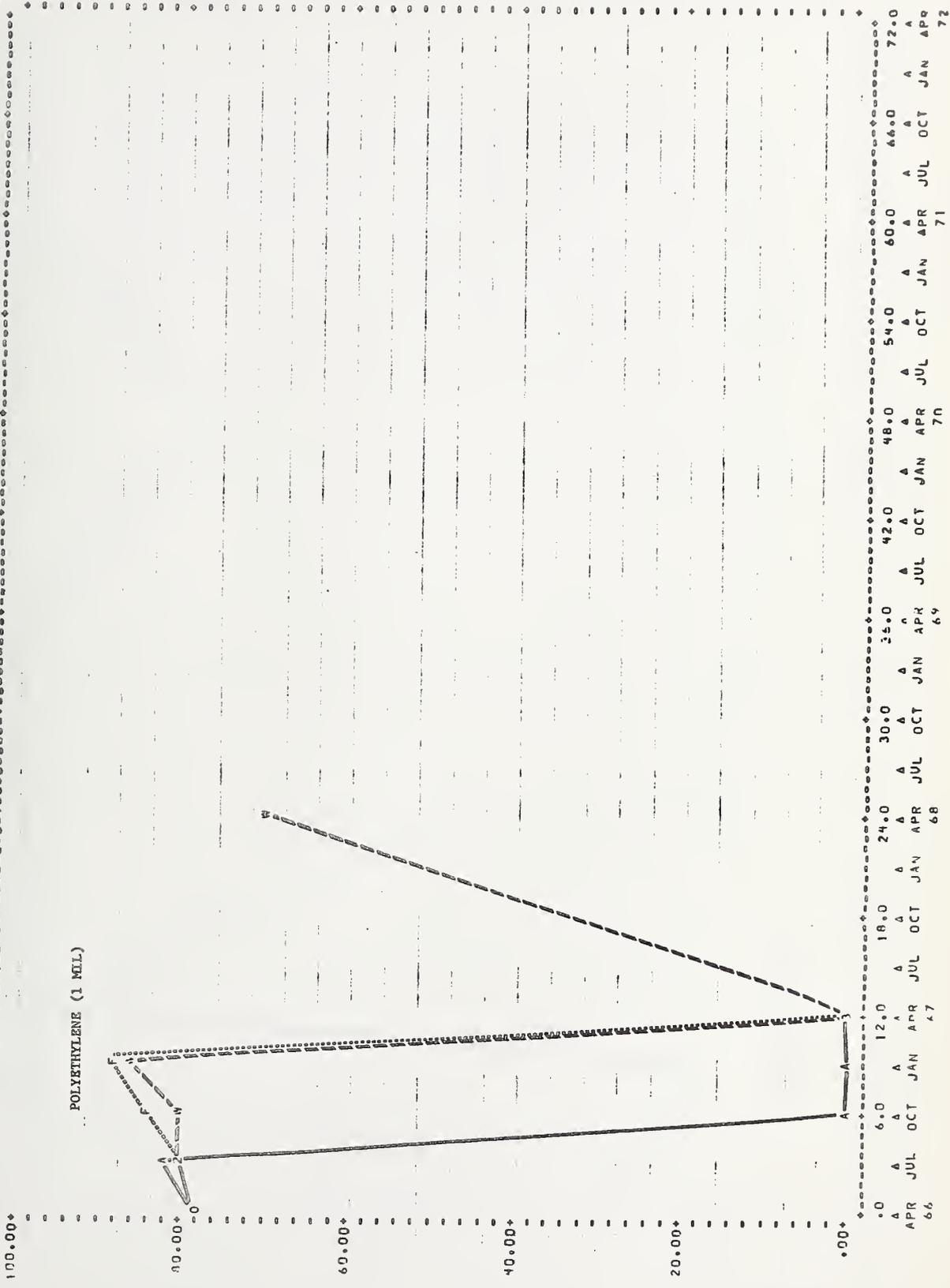


FIGURE 69B

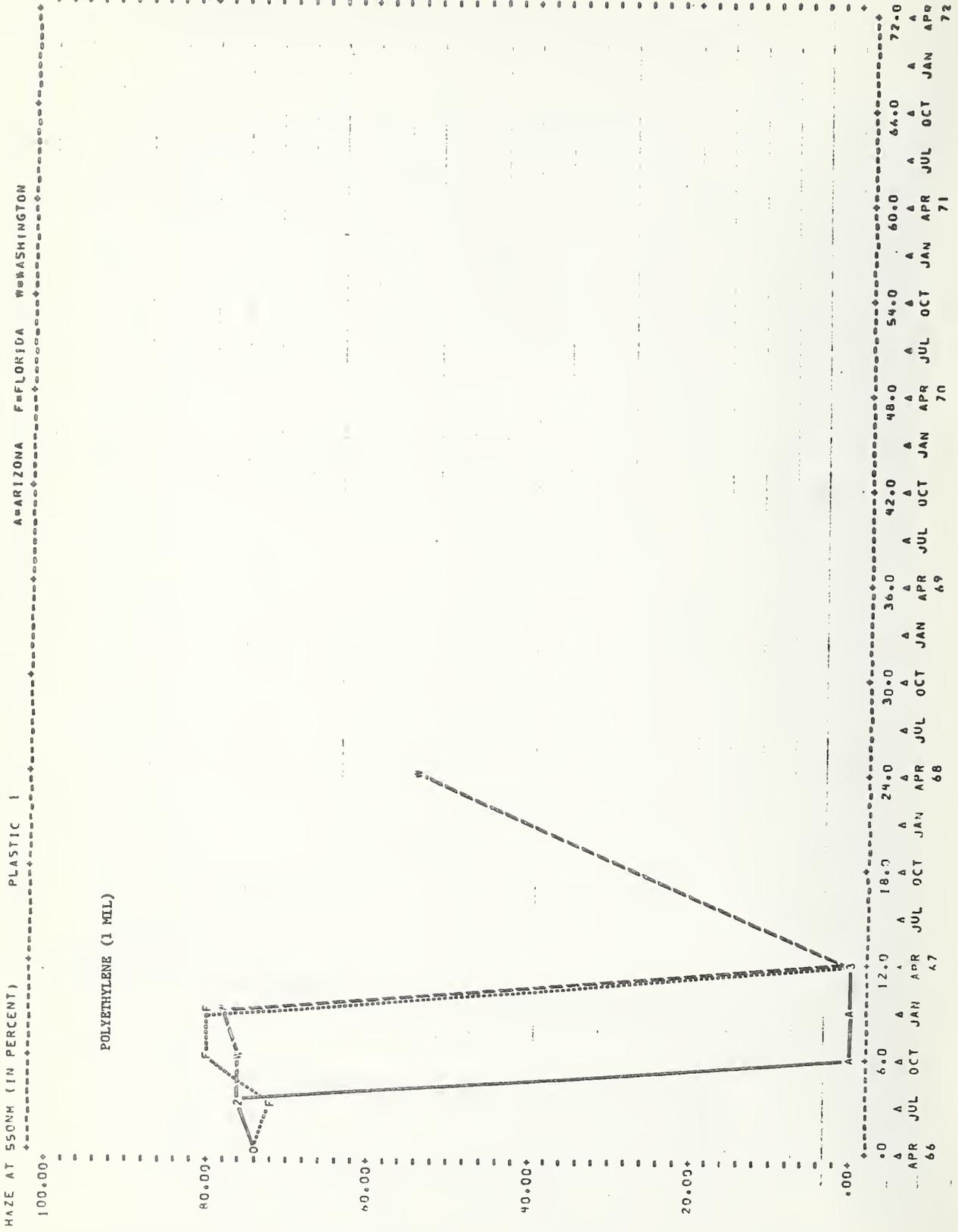
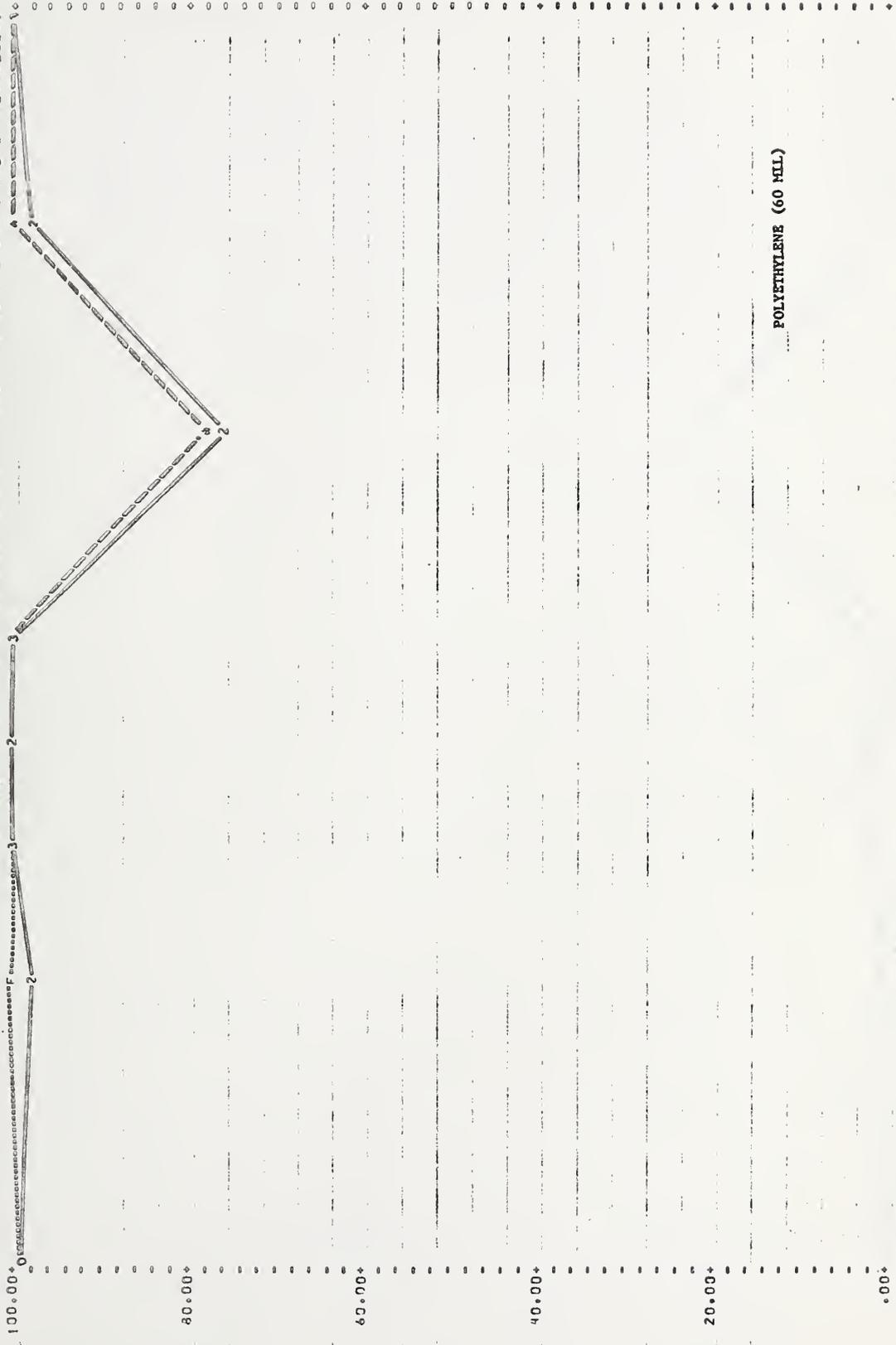


FIGURE 70A

HAZE AT 420NM (IN PERCENT) PLASTIC 2 ARIZONA FLORIDA WASHINGTON

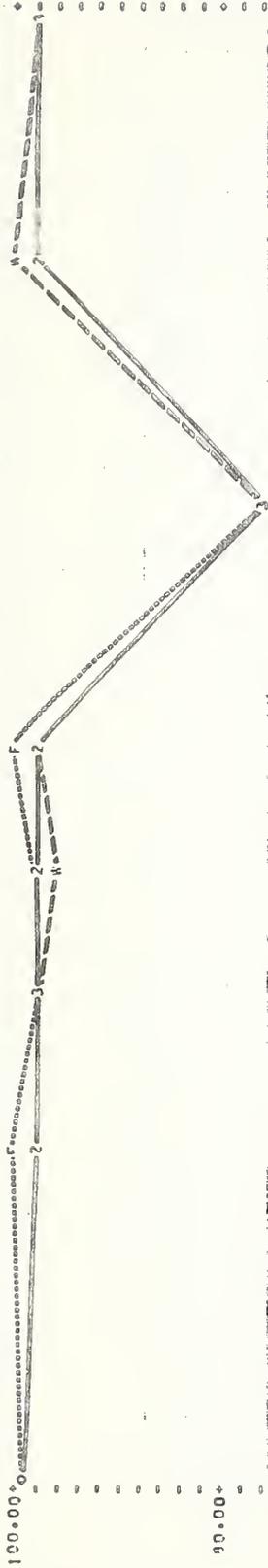


POLYETHYLENE (60 MIL)

0.00
20.00
40.00
60.00
80.00
100.00

FIGURE 70B

HAZE AT 550NM (IN PERCENT) PLASTIC 2 ARIZONA FLORIDA WASHINGTON



POLYETHYLENE (60 MIL)

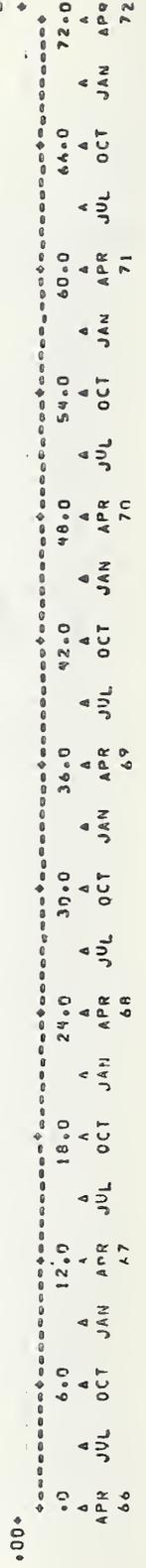


FIGURE 71B

HAZE AT 550NM (IN PERCENT)

PLASTIC 3

ARIZONA FLORIDA WASHINGTON

POLYMETHYL METHACRYLATE (60 MIL)

100.00

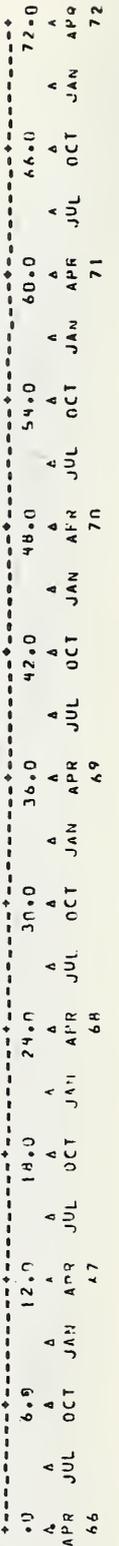
80.00

60.00

40.00

20.00

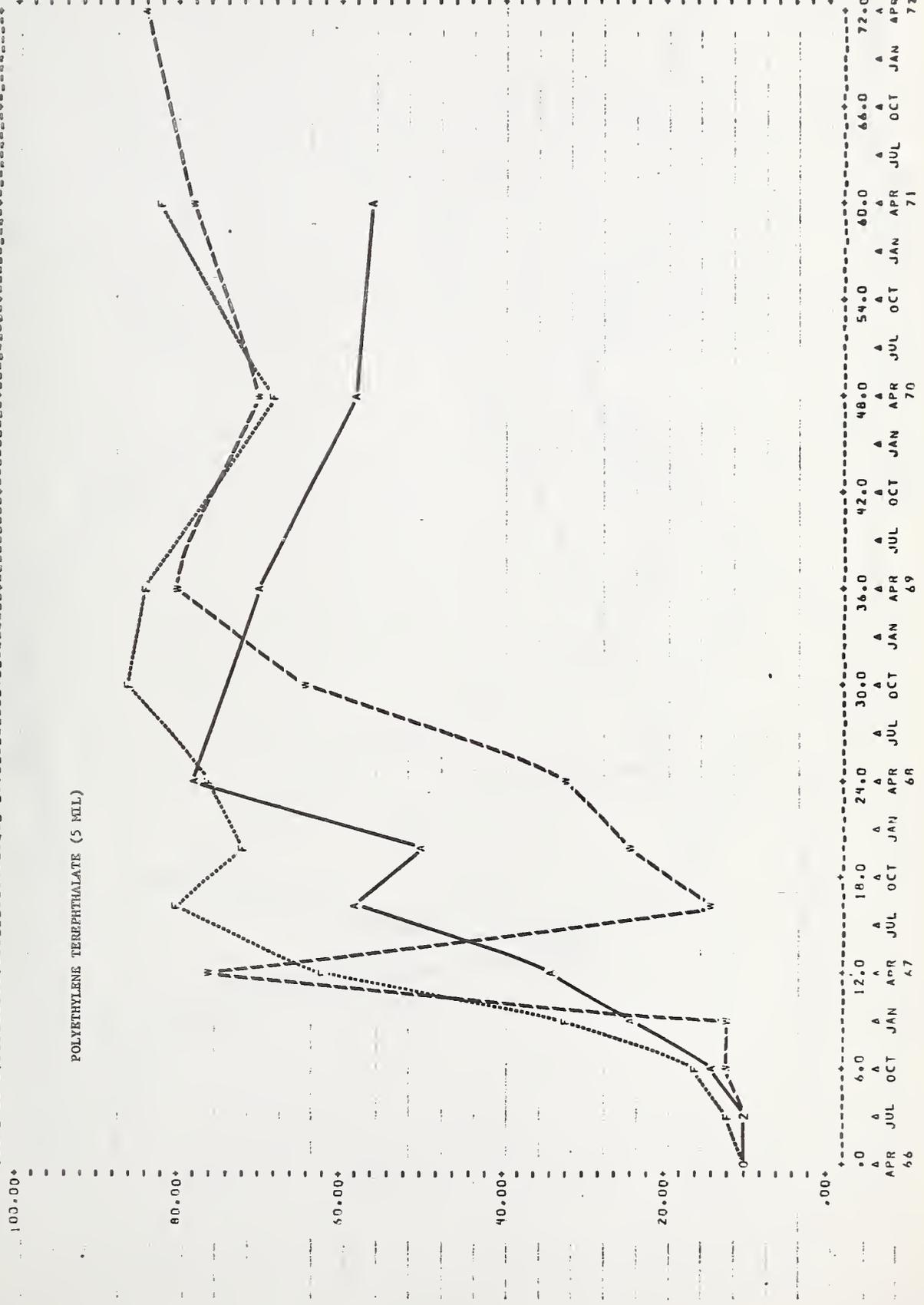
0.00



HAZE AT 420M μ (IN PERCENT) PLASTIC 5 ARIZONA FLORIDA WASHINGTON

POLYETHYLENE TEREPHTHALATE (5 MIL)

FIGURE 73A



HAZE AT 550NM (IN PERCENT) PLASTIC 5 ARIZONA F=FLORIDA W=WASHINGTON

POLYETHYLENE TEREPHTHALATE (5 MIL)

FIGURE 73B

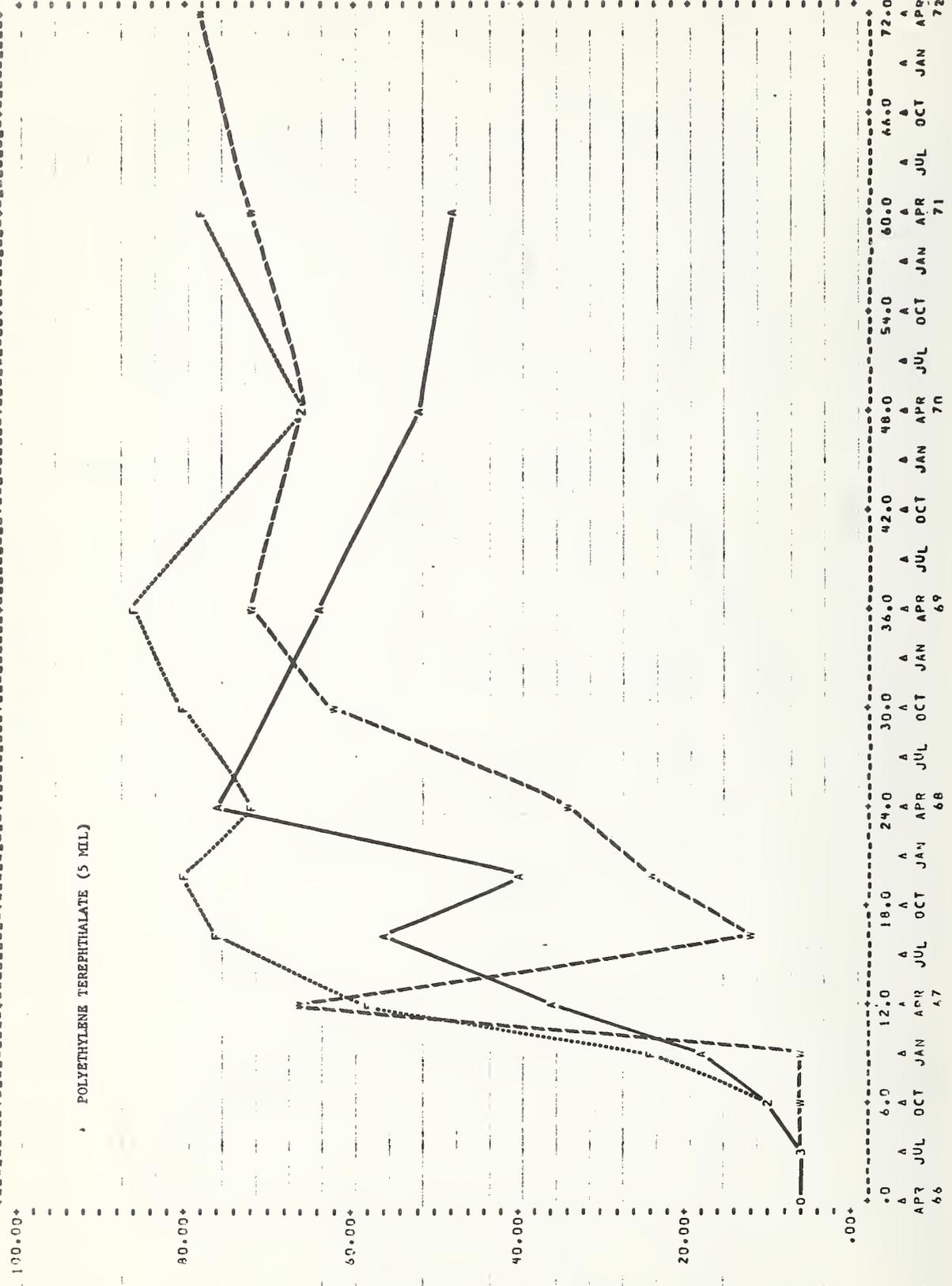
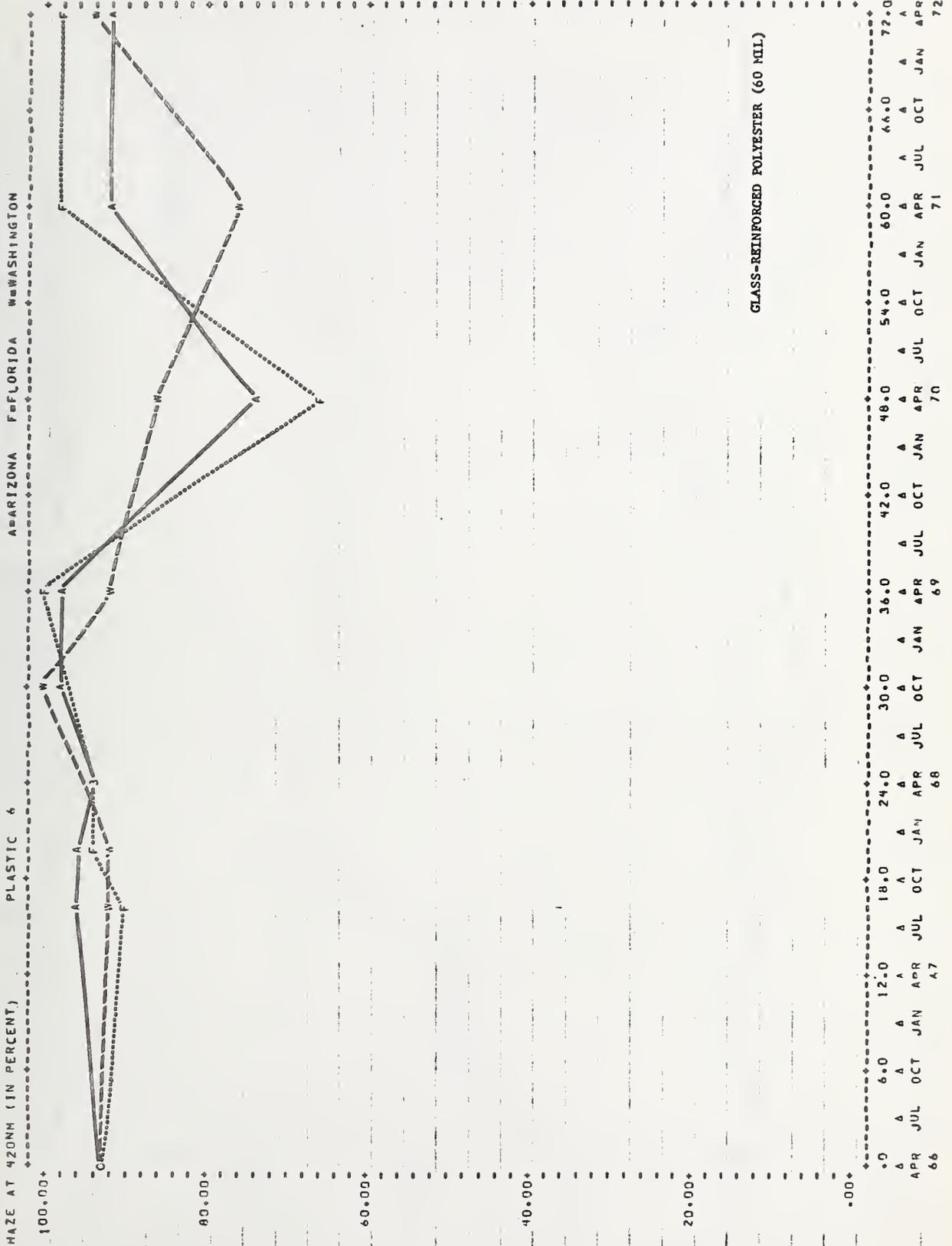


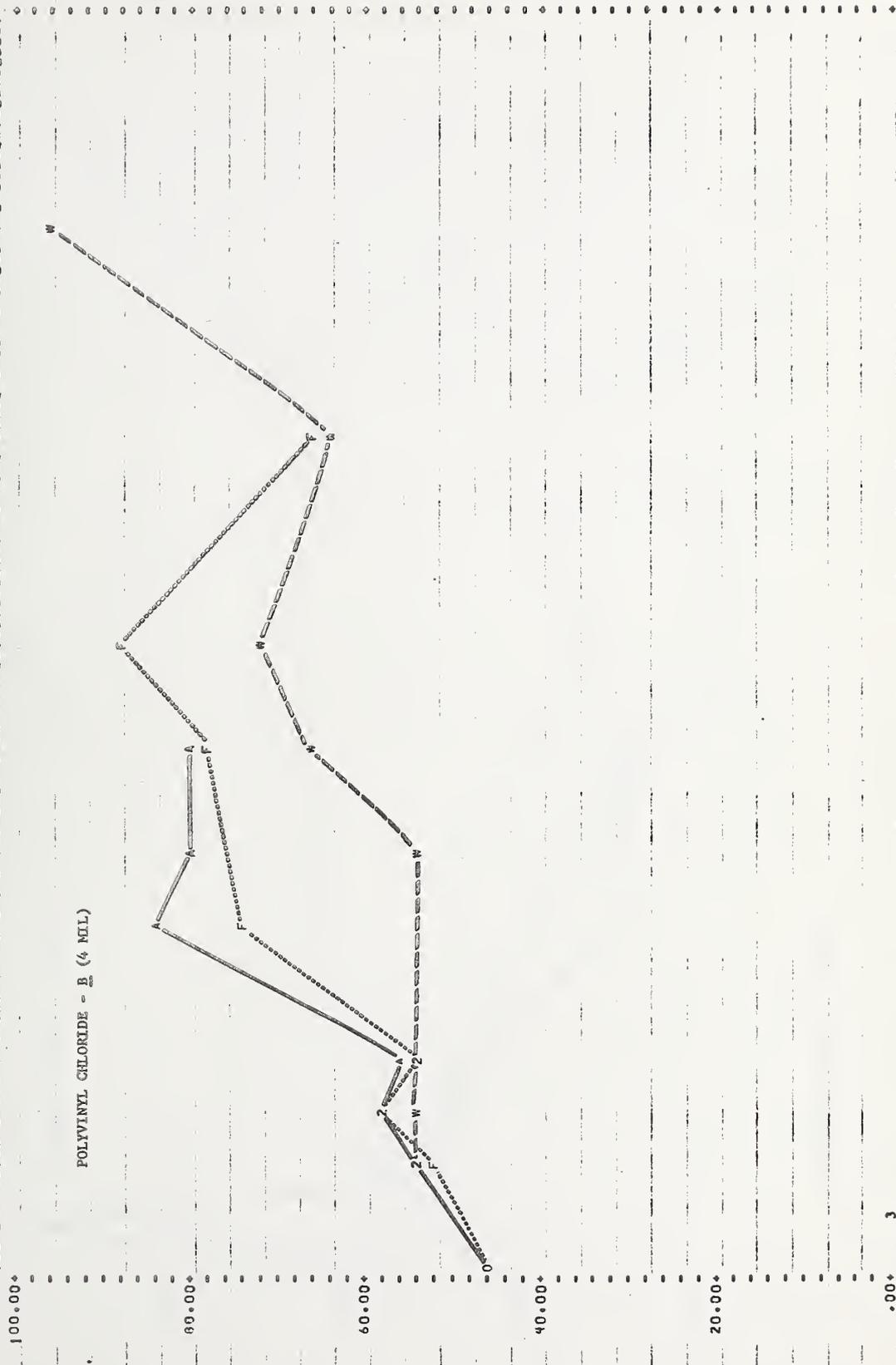
FIGURE 74A



GLASS-REINFORCED POLYESTER (60 MIL)

FIGURE 75A

HAZE AT 420NM (IN PERCENT) PLASTIC 7 ARIZONA FLORIDA WASHINGTON



00+ 3
 0 6.0 12.0 18.0 24.0 30.0 36.0 42.0 48.0 54.0 60.0 66.0 72.0
 APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR JUL OCT JAN APR
 66 67 68 69 70 71 72

FIGURE 75B

HAZE AT 550NM (IN PERCENT) PLASTIC 7 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (4 MIL)

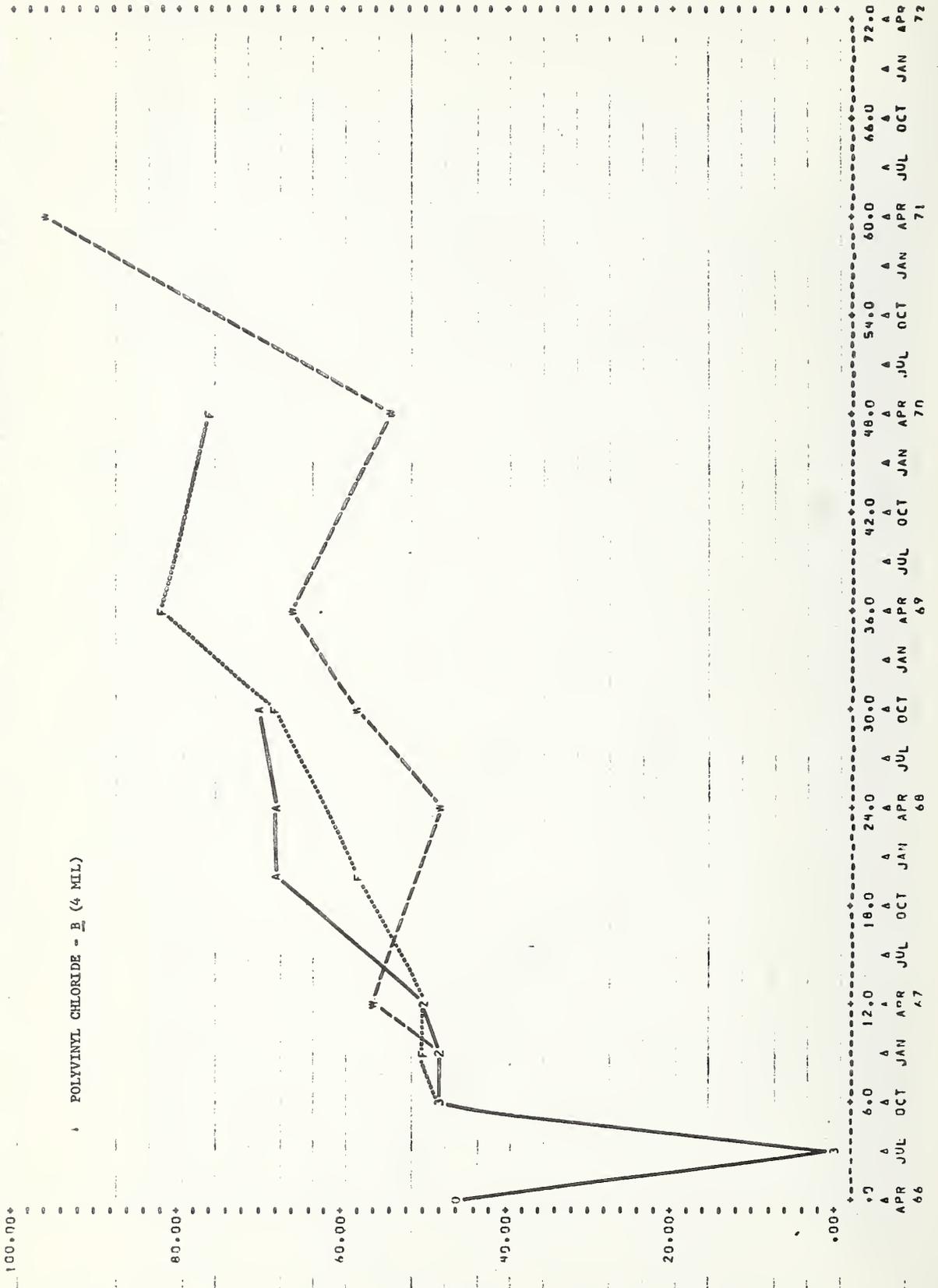
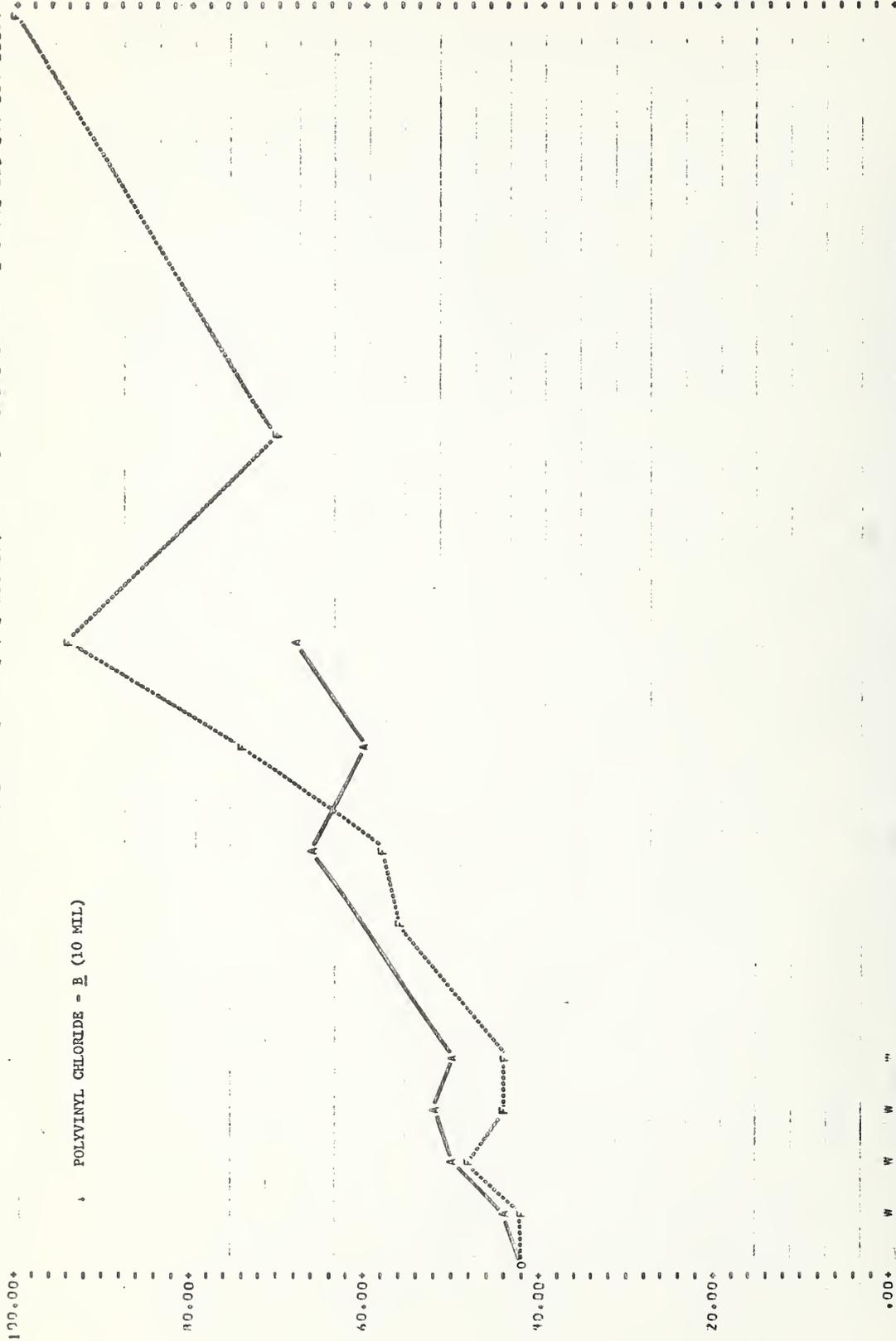


FIGURE 76B

HAZE AT 550NM (IN PERCENT) PLASTIC B ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - B (10 MIL)



0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00

APR JUL OCT APR JUL OCT

66 67 68 69 70 71 72

FIGURE 77A

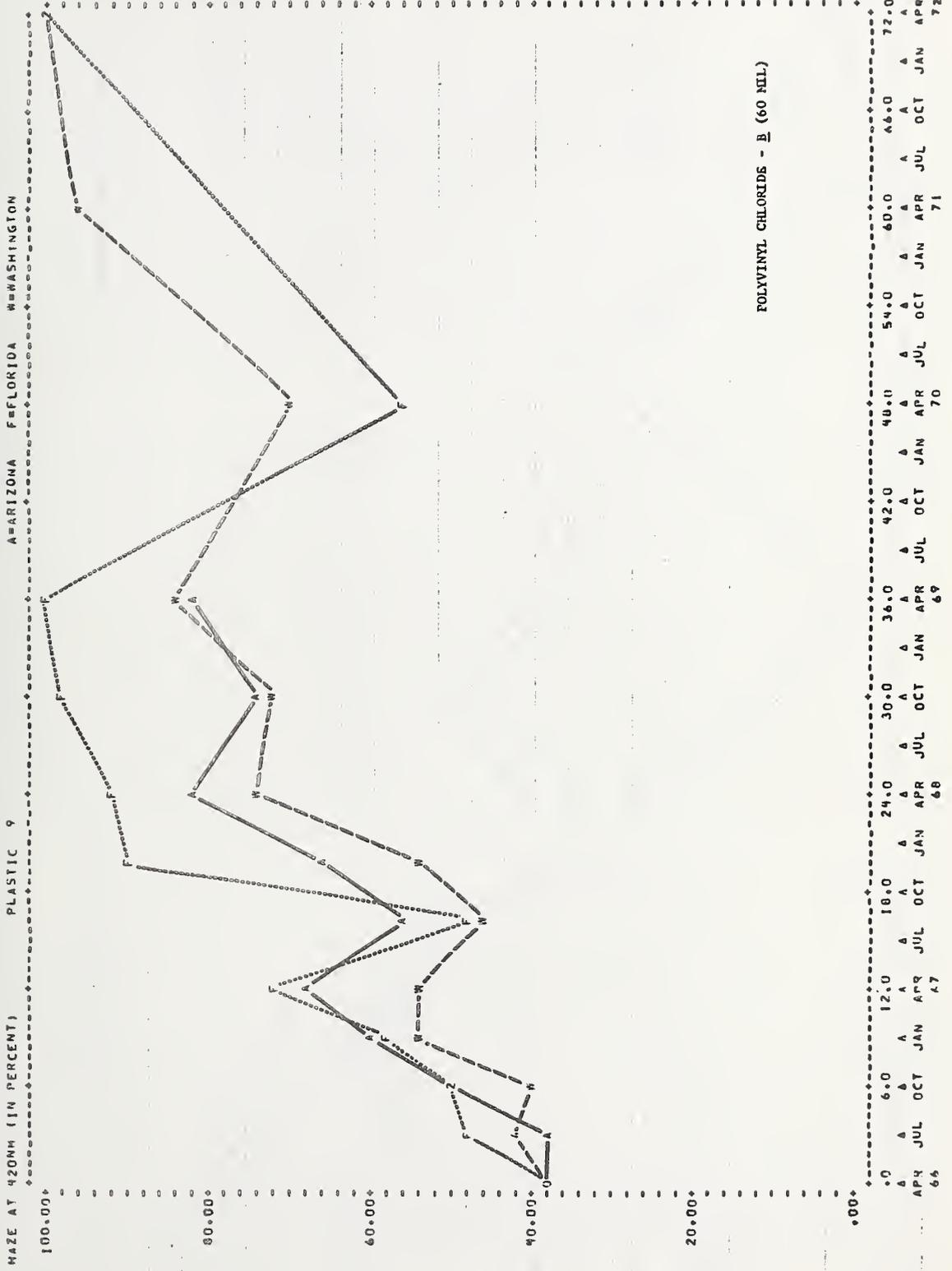
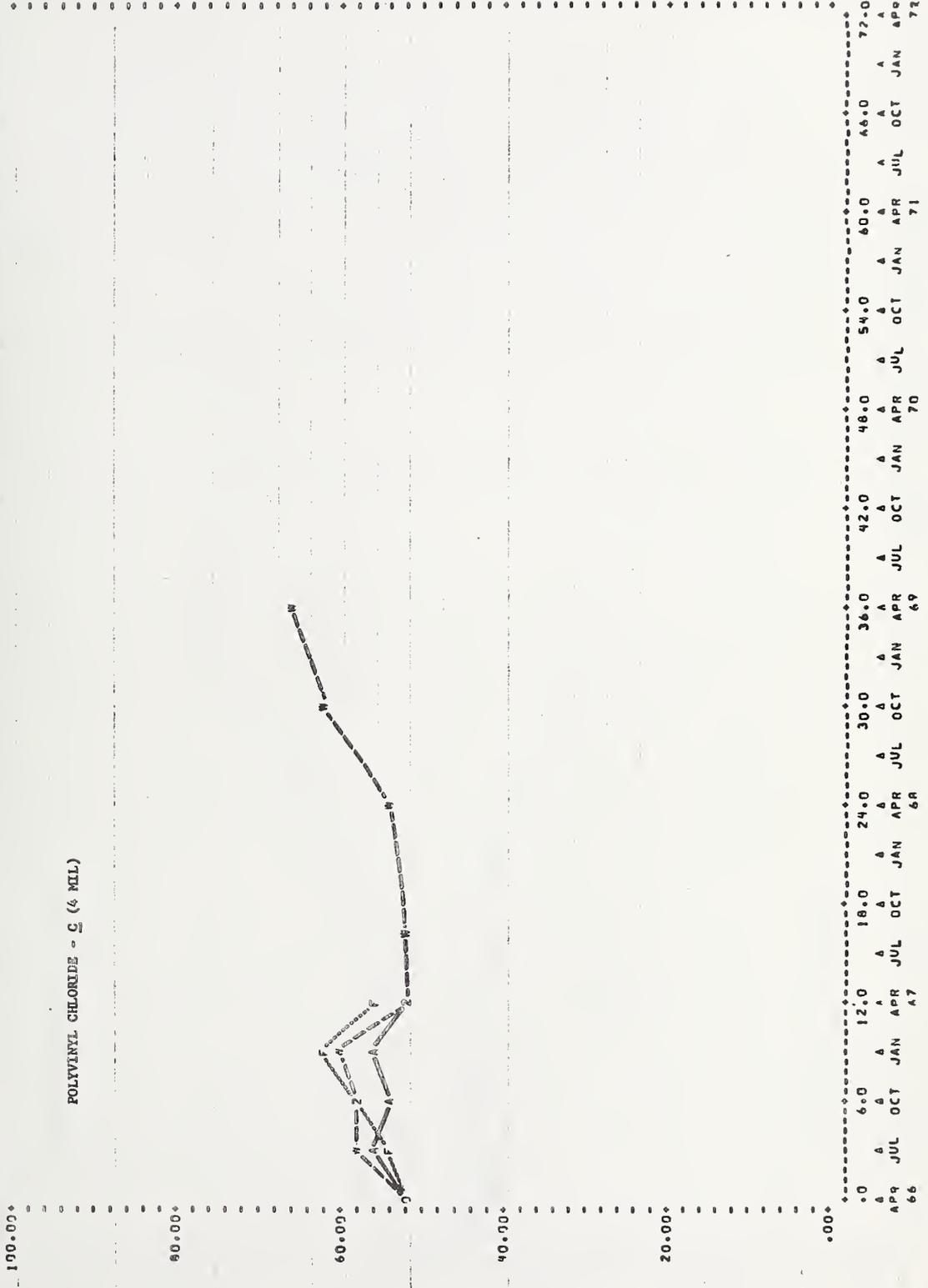


FIGURE 78A

HAZE AT 420NM (IN PERCENT) PLASTIC 10 ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - C (6 MIL)



HAZE AT 550MM (IN PERCENT)

PLASTIC 10

ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - C (4 MLL)

FIGURE 78B

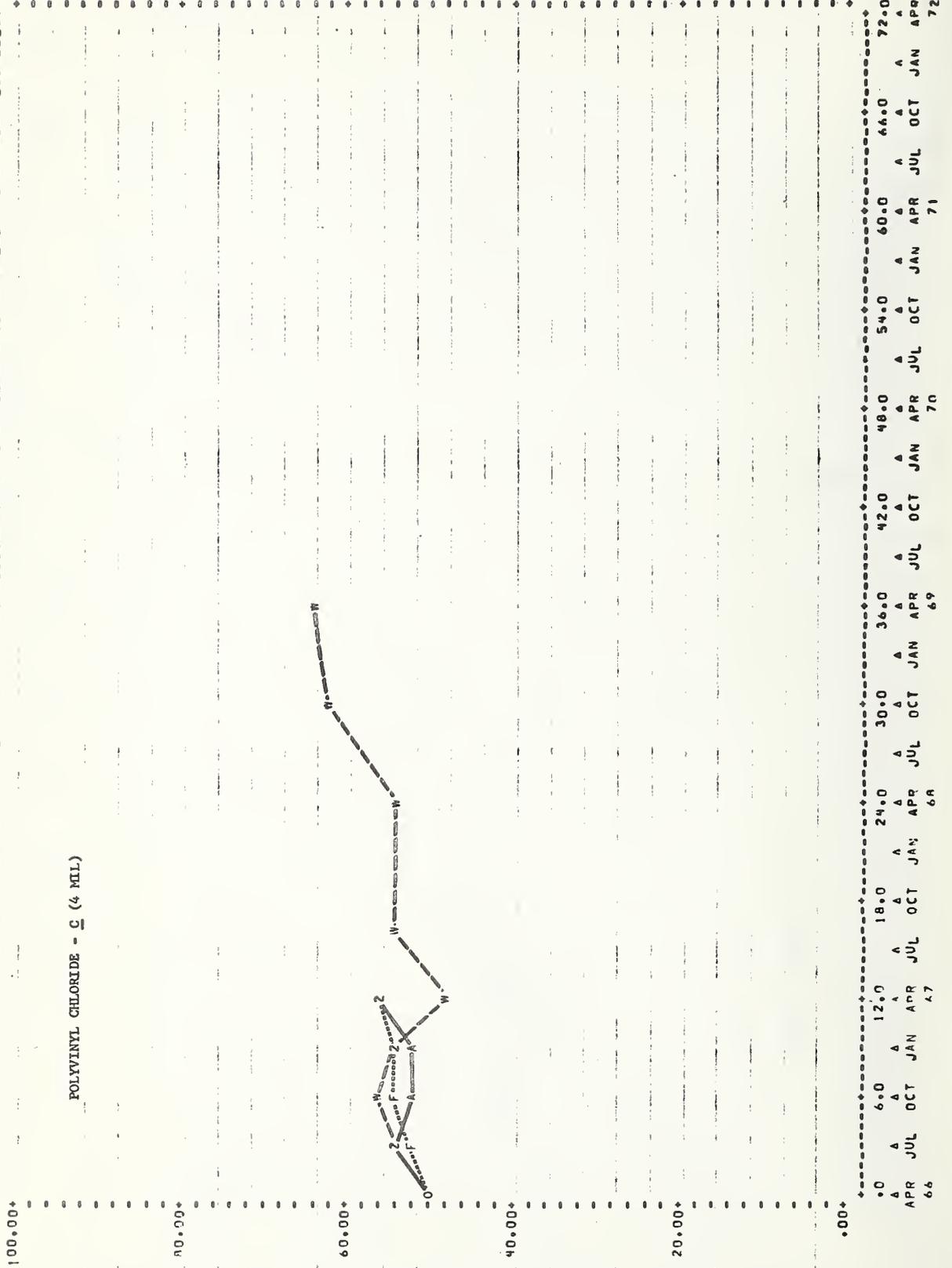


FIGURE 79A

HAZE AT 420NM (IN PERCENT) PLASTIC II A=ARIZONA F=FLORIDA W=WASHINGTON

POLYVINYL CHLORIDE - C (10 MIL)

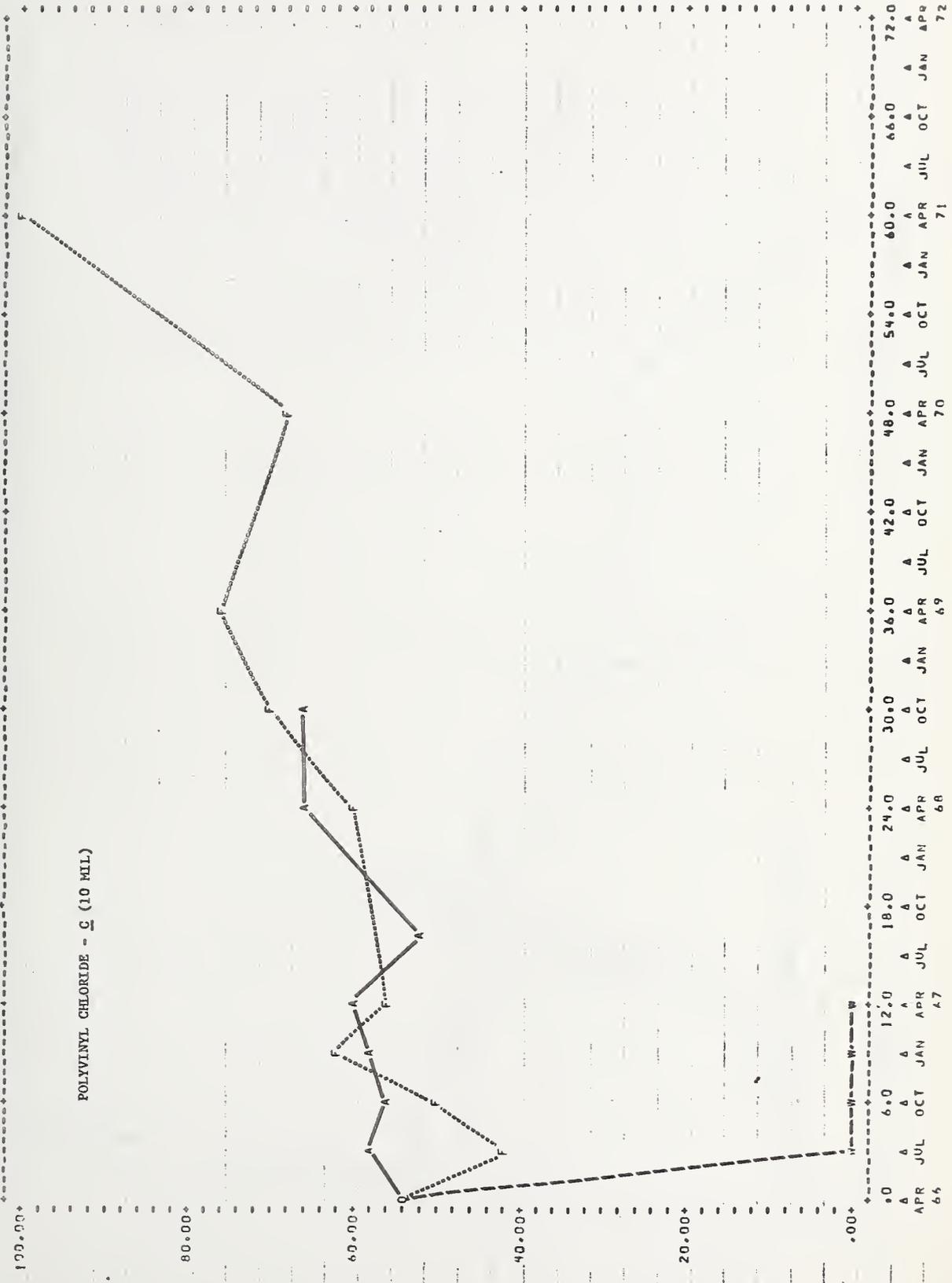


FIGURE 79B

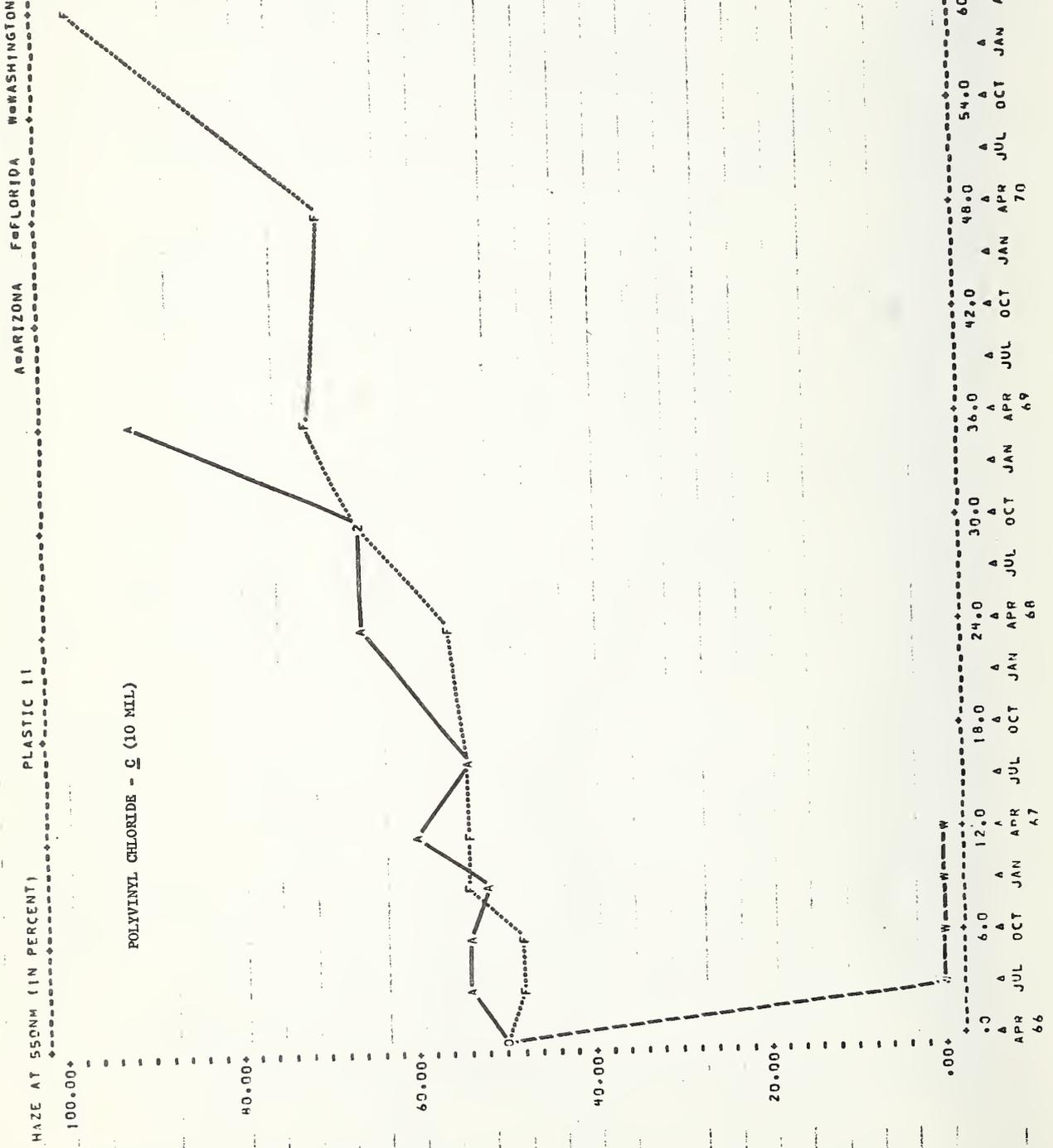


FIGURE 80A

HAZE AT 420NH (IN PERCENT) PLASTIC 12 ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE = C (60 MIL)

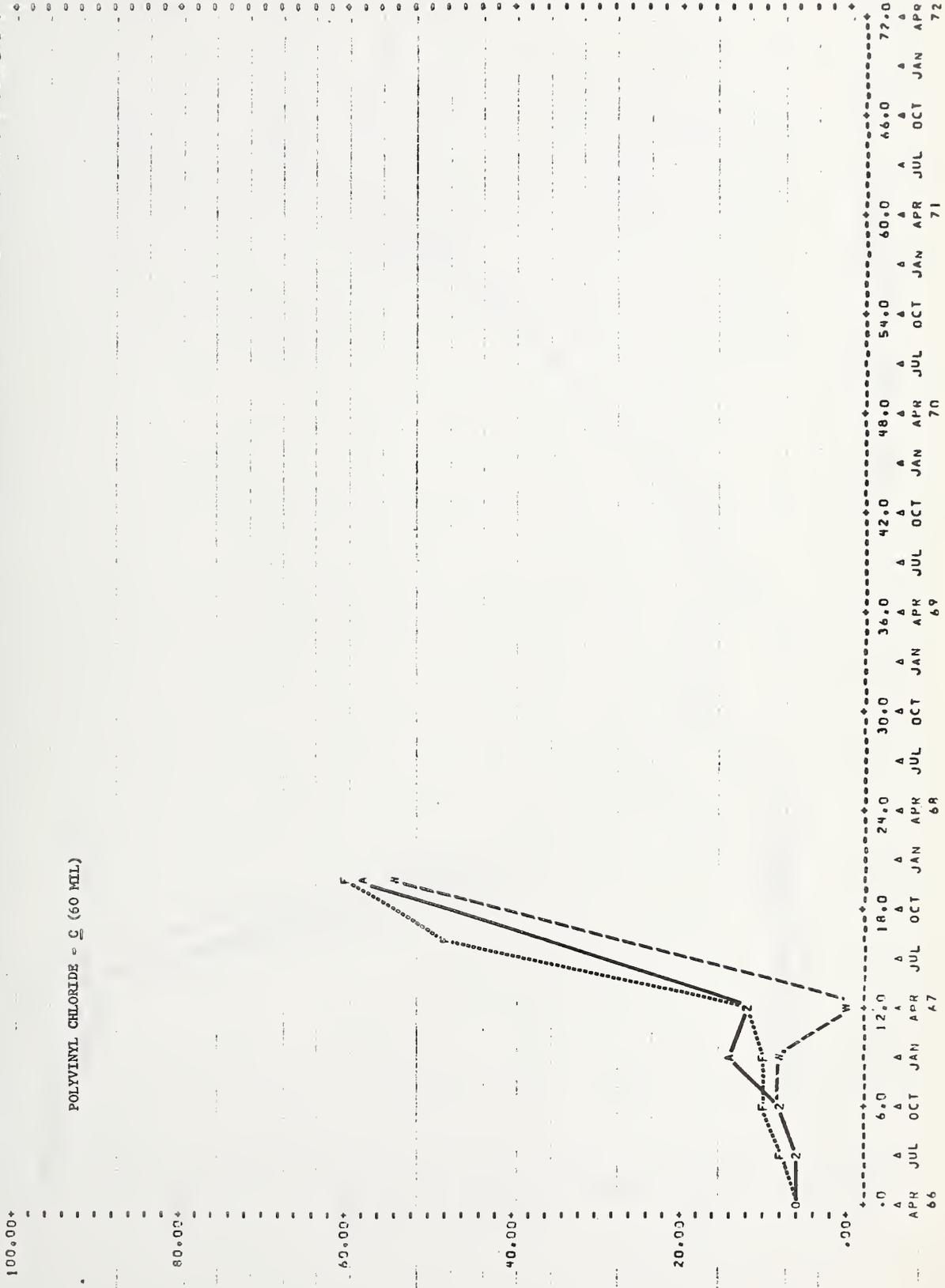


FIGURE 80B

WASHINGTON

FLORIDA

ARIZONA

PLASTIC 12

HAZE AT 550NM (IN PERCENT)

POLYVINYL CHLORIDE - C (60 ML)

100.00

80.00

60.00

40.00

20.00

0.00

APR JUL OCT JAN APR
 64 67 68 69 70 71 72

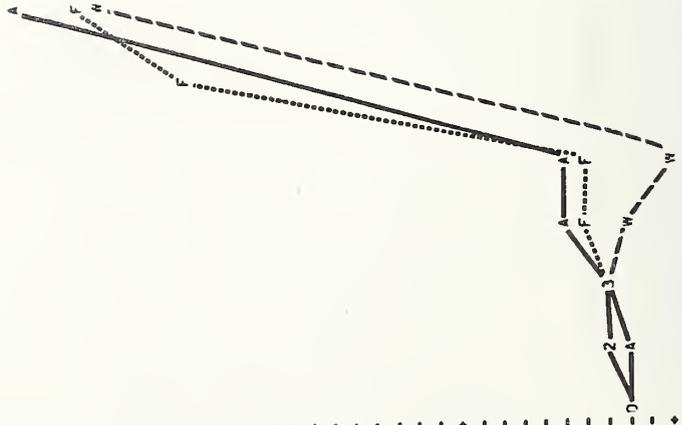


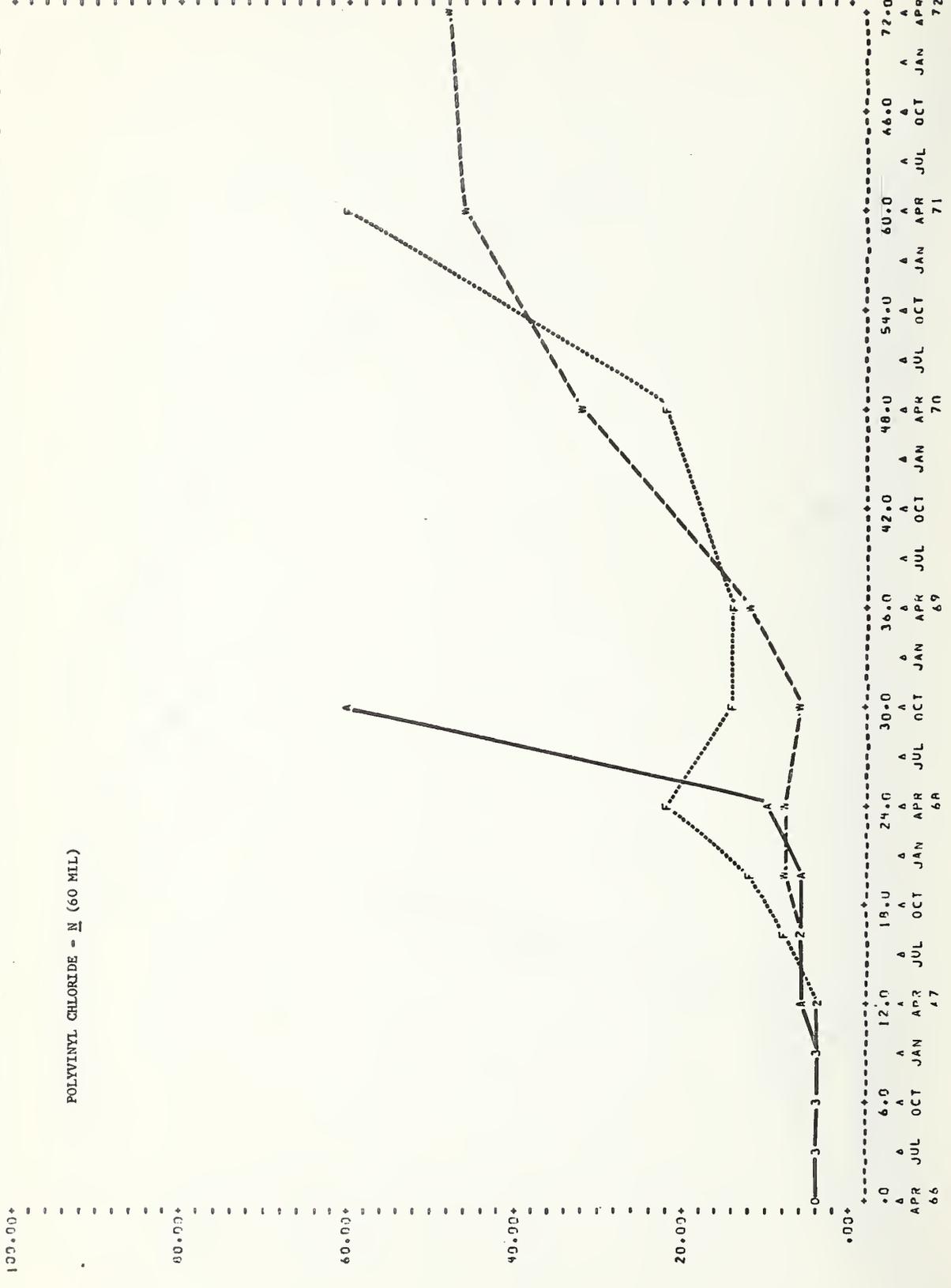
FIGURE 81B

HAZE AT 550NM (IN PERCENT)

PLASTIC 13

ARIZONA FLORIDA WASHINGTON

POLYVINYL CHLORIDE - N (60 MIL)



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<p>16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)</p> <p>Twenty plastics samples have been weathered in Arizona, Florida, and Washington, D. C. for 72 months. The weathering of these samples has been followed by measuring changes in the specimen's color, tensile, flexure, gloss, and haze properties. Computer-generated graphs of these changes with time are presented.</p>			
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